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EDWARD EMERSON BARNARD.

The flags were flying high at the Yerkes Observatory on Sunday, December 16, in honor of the sixtieth birthday of Professor Edward Emerson Barnard,* the senior partner at that institution.

In the afternoon the members of the colony on observatory hill, numbering with the children about forty, gathered at the home of Director and Mrs. Frost. Each of those present addressed to the guest of honor some original or quoted sentiment or verse, appropriate to the occasion.

Letters of congratulation and greeting, which had been received without the knowledge of Mr. Barnard from most of the astronomers of the country, and from others of his friends, were read. A cablegram in the name of the Royal Astronomical Society, signed by President McMahon, arrived just in time, with telegrams from others in the United States.

All of the greetings were particularly cordial to both Mr. and Mrs. Barnard, and expressed gratification at their continued health and activity. The great work that has been accomplished by Professor Barnard in thirty-five years of tireless astronomical research was mentioned in terms of the highest appreciation by the writers of the letters. The hope was generally expressed that Mr. Barnard's work might continue in its present full volume for many years to come.

* Born at Nashville, Tennessee, 1857. In charge of the observatory of Vanderbilt University, 1883-1887. Astronomer at the Lick Observatory 1887-1895. Professor of Practical Astronomy in the University of Chicago, since 1895, and astronomer at the Yerkes Observatory from 1897 to the present.

BENEATH MIDWINTER'S STARLIT DOME.

CHARLES NEVERS HOLMES.

Though far from friends or home
On northern strand or sea,
Wherever we may roam,
Whate'er our life may be,
Amid yon darkened sky
We see those stars once more
We saw in years gone by—
The same, same stars of yore!

Like a veritable sidereal diamond the incomparable and magnificent sun, Sirius of Canis Major, sparkles and scintillates, not far from where the dim and very remote Milky Way gleams and glimmers. Sirius—Canicula—Dog-star—Al Shira—sun of the winter evening or sun of the summer morning—glitters gloriously amidst the noticeable group of stars which adorns the south. Here is a firmamental jewel upon which we may gaze and gaze, and yet never weary of its wonderful brilliance. We may travel all over this wide world of ours, looking every night out of its vast dome-like window and not beholding anywhere such a sun as Alpha of Canis Major. Alpha of Carina, Alpha Centauri and Vega of Lyra, are each like gems of second-magnitude, although ranked as first magnitude suns, when compared with Sirius. The Dog-star—Canicula—of Canis Major!—it is no wonder that Mrs. Sigourney wrote of him:

"Hail, mighty Sirius, monarch of the suns!
May we in this poor planet speak with thee?"

But incomparable Canicula is not the only conspicuous sidereal ornament which bespangles midwinter's starlit dome. Capella, Aldebaran, Betelgeux, Rigel, Procyon and Regulus are, every one, star-jewels of fire. And just as Sirius is "monarch of the suns" of winter, so Capella is queen of winter's glorious Galaxy. As is well known, Capella blazes like a beacon at the apex of the constellation Auriga. Like Sirius she is enthroned close to the dim and remote background of the Milky Way, being at the summit of the glorious Galaxy whereas Sirius scintillates near the bottom. This starry queen of Auriga wears a golden cloak, but—alas!—one of her names is not royally dignified. It is the "Little She-goat". Nevertheless, she is well worthy of our study and admiration.

In the constellation of Taurus there are two very conspicuous sky objects—Aldebaran and the Pleiades. At the present time of writing there is also the giant planet Jupiter. As we know, Aldebaran is the fierce blazing "eye" of Taurus—how red and baleful is that eye! And the beautiful cluster of the Pleiades—the "Seven Sisters"—the "Starry Seven"—"Old Atlas' Children"—splendidly indeed has Lord Tennyson written of them:

> "Many a night I saw the Pleiads, rising thro' the mellow shade,
> Glitter like a swarm of fire-flies tangled in a silver braid."

And below Taurus is grand Orion!—and at once there recurs to the mind, "Canst thou bind the cluster of the Pleiades, Or loose the bands of Orion?"

Truly Orion is the grandest of winter's constellations! Its size is impressive, its outline remarkable, and its gems—Betelgeux, Rigel, and the others—are all resplendent. There is a majesty about Orion—a sublimity. Moreover, there is something wierd and mysterious about him. Like a gigantic Hunter or Warrior, belted by the three stars, Mintaka, Alnilam and Alnitak, he faces boldly the charging Taurus. Well has Manilius sung about this massive figure in the darkened sky:

> "Orion's beams! Orion's beams!
> His star-gemmed belt, and shining blade;
> His isles of light, his silvery streams,
> And gloomy gulfs of mystic shade."

With respect to Castor and Pollux it has been written:

> "Tender Gemini in strict embrace
> Stand clos'd and smiling in each other's Face;"

and although these two inseparable stars do not seem very conspicuous after we have gazed upon Sirius, Capella and Rigel, we cannot help noticing their silent aloofness among the suns of night. A telescope will reveal a considerable difference between Castor and Pollux but to the average eyesight they resemble each other very much. As they have been described:

> "So like they were, no mortal
> Might one from other know."

Below this constellation of the "Twins", the inconspicuous constellation of Canis Minor is to be seen—the first-magnitude sun Procyon being about all that is visible to human eye unassisted by telescope. And Procyon appears like a rather ordinary sun after the brilliance of

some of the other stars of the glorious Galaxy. So we glance eastward to the remarkable constellation of Leo, and pause there to admire bright Regulus at the bottom of his sickle-shaped group of six stars. Regulus is well worth admiring but this "Sickle" of Leo is more attractive in appearance than he. Of course we have left the glorious Galaxy, which belongs properly to the winter season, and have taken a look at Leo, a star group which lingers in our evening skies until very near the end of summer. It is certainly a most unique constellation; its "Sickle" resembling also a reversed "question-mark" or some kind of mysterious star-sign in our firmament.

Situated above this starry "Sickle" we behold the Great Dipper of Ursa Major revolving around and around the Small Dipper of Ursa Minor, where twinkles the faithful though not remarkably brilliant star, Polaris—the famous North star. As we all of us know, this North star is most important in that it keeps practically a fixed position in our northern sky. Respecting Polaris, the poet Bryant has sung:

"Constellations come, and climb the heavens, and go,
Star of the Pole! and thou dost see them set,
Alone in thy cold skies,
Thou keep'st thy old unmoving station yet,
Nor join'st the dances of that glittering train,
Nor dipp'st thy virgin orb in the blue western main.

"On thy unaltering blaze
The half-wrecked mariner, his compass lost,
Fixes his steady gaze,
And steers, undoubting, to the friendly coast;
And they who stray in perilous wastes by night,
Are glad when thou dost shine to guide their footsteps right."

We have not forgotten Draco, Cepheus, Cassiopeiae, Perseus, Andromeda, Triangulum, Aries, Pisces, Cetus, Eridanus and the other constellations that sparkle or twinkle on midwinter evenings. The poets have observed and admired these constellations, and have written concerning them. As, for example, in Mrs. Browning's *Paraphrases on Nonnus*:

"A place where Cassiopea sits within
Inferior light, for all her daughter's sake."

Or, from Keats' *Endymion*:

"Andromeda! Sweet woman! why delaying
So timidly along the stars: come hither!
Join this bright throng, and nimbly follow whither
They all are going."

And, again in Mrs. Browning's *Nonnus*:

> "Perseus, even amid the stars, must take
> Andromeda in chains aetherial!"

Brilliantly, gloriously, the suns and constellations of winter sparkle and scintillate above us. There is no moon to outshine them, no cloud to veil them. The atmosphere is clear as crystal and the star-gazer stands amid a perfect night, beneath a perfect sky! Around him there is deep silence, although at times a murmur afar from suburban life reaches his ears. No electric or other artificial light interferes with his firmamental study. Sirius, Capella, and Rigel seem never to have shone so brightly; Orion is indeed like a sidereal Giant, bespangled with gems. Then the cold, crisp air is like a tonic, it is not sharp and it is wholesome. But now the Moon is beginning to rise above a wooded knoll and a distant church-clock commences to drone the hour of *ten*. The star-gazer returns his opera-glass to his pocket; after another long keen survey of the flawless firmament he leaves the large frozen meadow—for his home. Brilliantly, gloriously, the suns and the constellations sparkle and scintillate above him. Enthusiastically, joyously, he may exclaim:

> Midwinter's suns!—when bleak and chill
> The frost king reigns o'er vale and hill,
> When nature sleeps as though in death
> And air is still—not e'en a breath,
> When Earth lies ice-bound out of door
> We see midwinter's stars once more.
>
> How glorious, sublime and bright
> These stars adorn yon dome of night;
> Ah! how inspiring is the sight—
> This threshold of the Infinite!

Newton, Mass.
41 Arlington St.

TWENTY-FIRST MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

[*Continued from Vol. XXV, page 668.*]

DETERMINATIONS OF STELLAR PARALLAX AT THE ALLEGHENY OBSERVATORY.

By Frank Schlesinger.

Since the installation of the Thaw Refractor in September 1914, this instrument has been used at the beginning and at the end of every suitable night for the determination of stellar parallaxes. The average length of exposure is only a little more than half a minute as against more than five minutes in the case of the most powerful visual refractors that are being used for similar work, and as against fifteen minutes in the case of the Cassegrain reflector. The accumulation of observational material is consequently very rapid and suffices for the determination of from 120 to 150 parallaxes a year, with an average probable error of less than 0″.01. Up to the present the parallaxes of more than 200 stars have been determined. Their accuracy is compared below with that of the writer's earlier work with the Yerkes telescope, and with the more recent determinations with the same instrument by Lee, Joy and Van Biesbroeck. In the former are included only those stars for which the rotating sector was used to reduce the apparent magnitude of the parallax star, and those for which the parallax star was originally about as faint as the comparison stars.

	Average Probable Error for One Plate	Average Probable Error of a Parallax	Average Number of Plates	Average Number of Comparison Stars	Number of Images on a Plate
	mm				
Earlier Yerkes	″.018=.0017	″0.0103	13	4.2	3
Later Yerkes	.020=.0019	.0091	12	4.9	2
Allegheny	.022=.0015	.0085	14	3.6	3

A discussion shows that the plate error common to all the images that appear on the same plate has an average probable value of 0″.011, almost all or quite all of which can be accounted for as distortion of the film; the seasonal error (common to all the plates taken in the same season) is also small, having an average probable value of 0″.007. These numbers enable the observer to decide how many images to

secure on a plate, how many plates to secure in a season, etc., in order to arrange the observing program most economically. The rotating sector suffices to reduce stars not brighter than 3.5 magnitude to the mean brightness of the comparison stars. For stars brighter than this an additional reduction is necessary, and several methods for effecting this have been tried. The plates not only furnish the parallaxes of the stars but also their proper motions; these are not directly comparable with proper motions derived from meridian observations, since the former are relative and the latter absolute. The difference between the two in any particular case may be regarded as the mean proper motion of the comparison stars in that field. A preliminary discussion of these differences shows very clearly the effect of the parallactic drift due to the sun's motion. When the present program for parallax work at this observatory is complete there will be at hand information concerning the proper motions of several thousand of the comparison stars, whose average photographic magnitude will be about 10.5, and these data will not only enable us to determine their mean parallaxes, but should also shed light on the question of star streaming for faint stars.

THE LOCATION OF THE SUN'S MAGNETIC AXIS.

By F. H. Seares, A. van Maanen, and F. Ellerman.

Certain lines of the solar spectrum, observed through a compound quarter-wave plate and Nicol prism in front of the slit of the spectrograph, show displacements produced by the sun's general magnetic field. The magnitude of any displacement is a function of the magnetic properties of the line, the position of the observer, the heliocentric latitude of the point observed, and the position of the sun's magnetic axis.

As a function of latitude alone, the other factors being constant, the displacements define a curve—the displacement curve—which is very nearly a sine curve, with zero values at latitudes 90° S, 0°, and 90° N, and maximum absolute values at 45° N and S. The rotation of the sun causes the magnetic axis to revolve about the rotation axis. This change in the position of the magnetic axis produces a small periodic shift of the displacement curve in its own plane whose amplitude (corresponding to about 0.001mm in the measured displacements) is a function of the mutual inclination of the two axes.

A discussion of the displacement curves for 63 days, distributed over an interval of three and one-half months, gives the following elements

for the sun's magnetic axis (assuming the sun to be a uniformly magnetized sphere):

Inclination	$i = 6°.2 \pm 0°.4$
Period	$P = 31.79 \pm 0.31$ days
N. Mag. P. on C. M.,	$t_0 = 1914$, June 25.31 ± 0.42 days G. M. T.

Systematic errors have been carefully controlled, and do not appreciably affect these results.

OBSERVATIONS OF THE AURORA SPECTRUM.

By V. M. Slipher.

The observations begun in June, 1915, testing for general auroral illumination of the night sky have been continued. No spectrum plate of the night sky has failed to record the presence of aurora light; the chief auroral line is present on all plates.

Measures on some of these test plates indicated a considerably greater wave-length for the aurora line than the accepted value, and a few higher dispersion spectra were secured for a more accurate determination. These give a wave-length of $\lambda 5578.0$, the results from the separate plates agreeing among themselves within 0.1 of an Ångstrom unit.

SPECTROGRAPHIC OBSERVATIONS OF STAR CLUSTERS.

By V. M. Slipher.

This paper presents some results of the spectrographic observations of globular star clusters. The velocities for the ten clusters observed are as follows:

N. G. C.		Velocity	N. G. C.		Velocity
5024	*M 53*	− 170 km	6341	*M 92*	− 160 km
5272	*M 3*	− 125	6626	*M 28*	± 0
5904	*M 5*	+ 10	6934		− 410
6205	*M 13*	− 300	7078	*M 15*	− 95
6333	*M 9*	+ 225	7089	*M 2*	− 10

While these velocities are distinctly lower than those of the spiral nebulae they are, however, much higher than star velocities.

SOME RECENT IMPROVEMENTS IN THERMO-ELECTRIC APPARATUS FOR PHOTOGRAPHIC PHOTOMETRY.

By Harlan True Stetson.

The present paper is a report of certain improvements effected in the reconstruction of the the thermo-electric photometer first described at the Evanston meeting of the Society. The entire apparatus has

been replaced by a much more serviceable design. The original luminant, consisting of a 52 volt 200 watt lamp, has been replaced by a small 6 volt 10-20 watt nitrogen lamp operated by a portable battery. A new optical system with a Leeds and Northrup Type R galvanometer has greatly increased the sensitiveness.

Remeasurements of plates previously measured indicate much smaller accidental errors. The probable errors with the new apparatus for a set of three readings on a faint star image is 0.009 magnitude as compared with 0.025 magnitude previously obtained for the same plates.

With such small accidental errors it is hoped an investigation of the errors of the photographic plate will yield results of much interest.

WEATHER PROSPECTS FOR THE TOTAL ECLIPSE OF 1918, JUNE 8.

By David Todd.

Following up the method of making cloud observations at special stations along the totality track, at the time of day when the eclipse is to occur and during the same period of the year, it appears that the best conditions are afforded in Idaho, Oregon, Washington, and Oklahoma, from systematic observations begun in 1912, and continued through 1917. The method is the same as that originated for the eclipse of 1893, subsequently employed for 1896, 1900, 1905, and 1914 with excellent results in locating observing stations.

PRELIMINARY RESULTS ON THE CONSTITUTION OF THE PLEIADES CLUSTER.

By R. Trümpler.

There has been much doubt about the angular diameter of the *Pleiades* group. Most observers adopted 1½ or 2° for it. Kromm found some evidence of stars sharing the proper motion of the group at a greater distance from the center. Besides that, the existence of extensive nebulae around the cluster makes a greater extension of the group likely.

More reliable data for the diameter of the group have been obtained:

(1) By counting the B. D. stars in concentric circles around the cluster to a distance of 5° from the center.

(2) By separating the physical members of the group from the background stars by means of the proper motions and spectra of the stars.

The results of the star counts are given in Table I. The density has been computed by dividing the number of stars by the surface of the

rings, and the number of group stars has been derived by assuming the mean density of the two outer rings as the density of background stars in the cluster.

TABLE I

	Brighter stars than 9.0 mag. B.D.			9.0—9.5 mag. B.D.		
Ring	Stars	Density	Group Stars	Stars	Density	Group Stars
0—1	63	63	51	55	55	27
1—2	56	18.7	20	96	32	11
2—3	79	15.8	19	159	32	17
3—4	87	12.4	(+3)	190	27	(−8)
4—5	104	11.6	(−4)	262	29	(+7)
Mean density of backgr. stars		12.0			28	
Total number of group stars			90			55

The star counts indicate a diameter of the group of 6°, and in the case of uniform distribution of the background stars, the group contains 145 of the B.D. stars (90 brighter than 9.0 magnitude, 55 from 9.0 to 9.5 magnitude).

The proper motions have been determined in a preliminary way from a comparison of recent photographic measures with the positions of the A. G. Catalogue. The star list is complete for the 198 stars brighter than the magnitude 9.0 of the B. D. within a radius of 3° from the center of the group, it contains besides that 36 fainter stars, and 9 stars lying outside the 3° limit, bringing the total number of stars to 243. The spectral types of most of the stars were available by kind communication of Professor Pickering.

As group stars only those stars were considered for which the proper motions as well as the spectral types were in close agreement; the rest were considered as background stars. Table II gives the number of group stars brighter than the B. D. magnitude 9.0 for the three inner rings, and a comparison with the corresponding results of the star counts; the agreement is very close.

TABLE II.

Dist. from Center	Group Stars	Density of Group Stars	Group Stars (Results of Star Counts)
0—1°	50	50	51
1—2	20	7	20
2—3	14	3	19
Total	84		90

The density of the group stars is very rapidly diminishing with increasing distance from the center.

In two entirely independent ways, by star counts and by studying the proper motions and spectra of the brighter stars, we are led to consider the *Pleiades* as a cluster containing from 80 to 90 stars brighter

than the B. D. magnitude 9.0, with an apparent diameter of about 6°, with a central condensation of nearly 2° diameter.

The number of group stars for the different magnitudes is given in Table III, together with the mean spectral type and the average number of background stars. The magnitudes are reduced on the system of the Potsdam Durchmusterung.

TABLE III.

Photometric Magnitude	Number of Group Stars	Mean Spectrum	Average Number of Background Stars
< 5.4	7	B6	0
5.5—6.5	6	B8	1
6.5—7.5	15	A0	7
7.5—8.5	27	A1	29
8.5—9.5	29	A9	72
fainter	(11)	F7	

Up to photometric magnitude 9.5 the number of group stars is increasing for each following magnitude, but the increase is much less rapid than the average increase of the stars in that part of the sky. The spectrum is advancing towards the red with diminishing brightness of the stars.

DISCUSSION OF THE MOUNT WILSON PARALLAXES.

By Adriaan van Maanen.

The paper deals principally with a search for systematic errors in the results of the fifty-one fields now finished.

As the full details of this discussion will appear in *Mount Wilson Contributions*, No. 136, it will suffice to mention only the final conclusion, viz. that there is no reason to suppose that the systematic error in the Mount Wilson parallaxes surpasses 0″.003.

ON A POSSIBLE LIMIT TO GRAVITATION.

By Frank W. Very.

It is assumed that gravitation acts by means of longitudinal waves of alternate condensation and expansion in a universal medium, which is also a magnetic medium, or "magnetic aura", composed of least parts, or magnetons, and which is subject to magnetic laws. Hence the gravitational wave at any instant is assumed to coincide with a magnetic equipotential surface and to follow in its progressions the curves of magnetic lines of force. Reasons are given for believing that the sphere of action of a given galactic mass of stellar material does

not extend to infinity, but is contained within a definite aural "cell," or is limited by the vortical motions of a particular body of the universal aura which is independent of neighboring similar bodies, possibly because there is repulsion between them, so that interference is impossible. Speaking relatively, the galaxies are rather closely packed, in total disagreement with the sparsity of stellar distribution; and the galaxies have also much greater speeds than the relative speeds of the stars which compose them; but, nevertheless, the galaxies show hardly any appearance of collision, or interpenetration—nothing which can not be explained as variation in a general magnetic control.

In confirmation of this view may be cited van Maanen's measures of the internal motions in *Messier 101.* The motions are *away* from the center, as if controlled by currents in the general medium, that is, the motions are not such as would be anticipated under the gravitational attraction of a central mass; and the flow appears to follow a law of the inverse *cube* of the distance which would be appropriate to a magnetic control. An attempt is made in this paper to devise a scheme of an atom, or least gravitative unit, which shall be capable of performing these functions and of sustaining these relations to a general magnetic medium; and it is shown that gravitational waves having a frequency about equal to that of a light wave will account for the phenomenon, if circumscribed by a boundary; but that otherwise it is not easy to account for the action on mechanical principles. Hence it is concluded that, somewhat as the molecules of gases move in every direction among themselves, but are nevertheless controlled by the more general currents of the larger gaseous mass, so the individual motions of stars, or of the lesser star clusters are local and under the control of a more general movement of the body of aura which contains them.

According to the kinetic theory of gases, the pressure in a gas is that due to the momentum of the colliding molecules themselves as finally reflected from the containing walls of an enclosure. Without a limiting wall, the given mass of gas would expand indefinitely until its molecules ceased to collide and there would be no pressure. In a galactic mass, on the contrary, the individual stellar units do not collide, and the compression is not produced by the onward motion of the stellar "particles", or of their least component atoms; but it is produced in the containing medium by an internal mechanism within the atom itself, thus in an entirely different way. Nevertheless, as in the case of the theory of gases, it is difficult to see how there can be any *pressure* unless there is a retaining wall. Such a cell wall for the gravitational pressure is presumably a discontinuity in the aura produced by its vortical motion. Thus the aural cell may be likened to a gigantic "vortex atom".

REPORTS OF COMMITTEES

REPORT OF THE COMMITTEE ON STELLAR PARALLAXES.

As in previous years the coöperating observers have kept each other informed as to additions to the observing lists, stars abandoned, etc. There has also been much helpful correspondence concerning methods, arrangement of the observing programs, choice of stars to be observed, and the like. Short reports from the individual observatories follow.

Allegheny Observatory. During the year 2500 successful parallax plates were secured and 2100 were measured. We have adopted the policy of not beginning to measure the plates for any one star until all the necessary plates have been secured. Accordingly the measuring is now up to date. More than two hundred parallaxes have been determined, of which eighty-one are in the hands of the printer, to appear in the publications of the Observatory. Experiments have been made (chiefly by Dr. Trümpler) with Kapteyn's recently proposed method for avoiding guiding error in the "wholesale" determination of parallaxes (that is, the relative parallaxes of all the stars that appear in a small field), and this method is now being tried on the Selected Areas in the $+30^\circ$ zone. Other methods for the same purpose have also been tried. Experiments have also been made to determine the best method for reducing the light of stars too bright to enable us to employ the rotating sector alone. During the year 175 stars have been added to the observing program. (FRANK SCHLESINGER).

Dearborn Observatory. Our two measuring engines are being constantly employed for the measurement of parallax plates. The new Gaertner engine arrived in August 1916 and has been giving satisfactory service since that time. We are devoting the greater part of our time to this work but we are handicapped by diminution of our staff on account of the war. The observing is being kept up and we now have about 2600 plates with 40 fields ready for the machine. During the year 800 plates were obtained. We have now completed the determinations for seventeen stars with an average probable error of $0''.009$. Three stars have been added to the observing list during the year.

(PHILIP FOX).

Greenwich Observatory. Our parallax work during the year is very meagre. We have not published any definitive parallaxes and have added no stars to our observing program. First exposures have been given on 86 plates, and second exposures on 150. Only 35 plates have been measured during the year. (FRANK WATSON DYSON.)

McCormick Observatory. A total of 4200 parallax plates have been secured here up to July 1, 1917. The parallaxes of 83 stars have been published in POPULAR ASTRONOMY, Vol. 25, page 23. Some of the stars there given, whose results were obtained from plates secured in three seasons only, were again put on the observing list in order to free the results for parallax and proper motion as much as possible from the chance of systematic error. Among such stars is *70 Ophiuchi.* The complete account of the parallax work at this observatory will shortly be published by Columbia University as an Ernest Kempton Adams Research. We have added 52 stars to our program during the year.

(S. A. MITCHELL).

Mount Wilson Observatory. Since the last report 412 plates with 554 exposures have been secured for the direct determination of parallaxes with the 60-inch reflector; 52 fields have been completed, most of them of stars of small proper motion with advanced types of spectrum. The exceptions are *6 Cygni* and *61 Cygni*, two Wolf-Rayet stars (B. D. + 35°4001 and + 35°4013) and the planetary nebula N. G. C. 7662. The results of this material have been discussed for probable and systematic error, and the publication is now with the printer. With the use of about 16 exposures the probable error is less than 0″.006. There is considerable evidence that the systematic error must be small, perhaps not exceeding 0″.003. During the year the observing program has been modified greatly. It now contains three lists of objects: 52 small proper motion stars with advanced types of spectrum; 28 stars of special interest, such as novae, variables, and members of the *Taurus* group; and 39 nebulae, most of which are planetaries.

For the spectroscopic determination of parallaxes the observing list is nearly identical with that for radial velocities and hence is an extensive one. It may be summarized as follows, stars of types A and B being omitted: (1) Stars with measured trigonometrical parallaxes, brighter than magnitude 9.5. (2) Stars of very large proper motion, the list used being that published by van Maanen in the *Astrophysical Journal*, Vol. 41, 1915. (3) The star list of the *American Ephemeris.* (4) About 70 stars of very small proper motion, most of which have been or are now under observation by van Maanen. (5) A list of about 200 stars of types G and K for which the radial velocities are being determined. The spectroscopic parallaxes of about 500 of these stars will be published within a short time by Adams and Joy. Preliminary determinations are available for several hundred others. The spectral parallax results for 21 stars were published in the Publications of the Astronomical Society of the Pacific, December, 1916.

(W. S. ADAMS).

Sproul Observatory (Swarthmore College). We have added six stars to our observing list and abandoned 21. The parallaxes of 50 stars have been published in *Sproul Observatory Publication*, Number 4; 25 additional regions have been completed and 27 others lack only the last epoch. Some of these fields will be held over for a year on account of the extremely poor observing conditions this spring. For the same reason we have obtained only 529 plates during the year. In spite of the fact that our standard has been raised and that we now discard plates that would formerly have been measured, the percentage of rejected plates has been cut in half. (JOHN A. MILLER).

Van Vleck Observatory (Middletown). The double slide plate holder is finished, and experiments have been started to see what sort of parallax results can be obtained with the old 12-inch lens. There is no prospect of getting the 18½-inch lens until after the war.

(F. SLOCUM).

Yerkes Observatory. Part I of Volume IV of the *Publications of the Yerkes Observatory* is in press and contains the data for 132 stellar parallaxes thus far obtained with the 40-inch telescope. The results which have been published in detail in astronomical journals are given in summary form; for those stars for which a statement of results only has been given, the details are published in full. The new screw measuring machine (obtained with a grant from the Gould Fund) has been thoroughly tested and has been put into use. We have constructed in our shop a substantial device for obtaining "iso-magnitude" plates according to Kapteyn's plan (*Astrophysical Journal*, Vol. 41, page 77), and a number of photographs have been made with it, giving images of satisfactory equality for stars of different magnitudes. Two scattered clusters, N. G. C. 663 and N. G. C. 869, have been under investigation for proper motion, under Mr. Lee's direction, by Miss Vera M. Gushee and Miss Hannah B. Steele, respectively, using plates taken with the 40-inch telescope. During the year 645 plates have been obtained in this department, chiefly for parallax.

(EDWIN B. FROST).

REPORT OF THE CHAIRMAN OF THE COMMITTEE ON PHOTOGRAPHIC ASTROMETRY.

BY FRANK SCHLESINGER, CHAIRMAN.

PROGRESS OF THE ZONE CATALOGUE OF 7200 STARS OBSERVED WITH THE 3-INCH DOUBLET AT THE ALLEGHENY OBSERVATORY.

The observing list includes all the stars (5954) in the Nicolaieff Zone of the Astronomische Gesellschaft Catalogue, their declinations, being

between $-2^\circ\ 10'$ and $+1^\circ\ 10'$; and in addition about 1300 stars in the Albany Zone of the same catalog with declination south of $+2^\circ$.

One hundred and twenty plates were secured, each extending over 24 minutes of right ascension ($6^\circ\ 0'$) and covering an area of 25 square degrees. The center of each plate is on the edge of the preceding and also of the following plate. Each star was measured on two plates. The plates were first measured in the direction of right ascensions, they were then turned approximately 90° and measured in the direction of declination. Four bisections were made in each coördinate, two in each position of the reversing prism. In this zone it required 100 seconds to identify a star and measure its position in each coördinate.* The total time spent in observing, at the telescope and at the measuring engine, was 930 hours.

The plates were measured alternately in the direct and reversed positions. This plan eliminates the "right-and-left error" arising from the bisection of images of different sizes, and it enables us in this case to determine the errors of the measuring engine with an accuracy that is higher than can conveniently be attained by the usual methods.

In order to determine the plate constants, 602 comparison stars were employed, an average of ten to the plate. Each star position depends, on the average, upon fifteen comparison stars. These comparison stars were observed with the six-and-one-half-inch meridian circle of the Lick Observatory by Professor Tucker. The results come up to the high standard that this observer has maintained in his work with this instrument. The probable error of one position, the mean of four observations, comes out equal to $0''.195$ in right ascension, and $0''.19$ in declination.

The plates were reduced by Turner's method, a least-square solution being made in each coördinate for the purpose of determining three constants. The observation equations are of the form

$$\text{Measured coördinate} - ax - by - c = \text{the meridian circle place.}$$

Here x and y are the linear coördinates of the star and a, b, and c are three constants. These solutions gave as the probable value of one difference between the meridian circle place and the photographs

$\pm\ 0''.27$ in Right Ascension. $\pm\ 0''.24$ in Declination.

If we allow for the part due to the accidental error of the meridian circle places on the basis of the probable errors quoted above, we have left for the photographic error

$\pm\ 0''.19$ in Right Ascension. $\pm\ 0''.15$ in Declination.

* In the subsequent work it was found possible to reduce this time by about thirty per cent with the aid of an improved measuring engine and an improved method for identifying the stars.

These include accidental errors of bisection, distortions of the film, optical distortion and outstanding errors in the measuring engine. Guiding error and magnitude distortion are not included since the comparison stars are about equal in brightness.

The measures were next examined for all known sources of systematic error and for the possible presence of quadratic terms having an unknown origin. It was found that this doublet gives positions that are wholly free from optical distortion within the area covered by these measurements. The magnitude distortion is also small, amounting to 0″.06 per magnitude at 3° from the center. (A more complete investigation of this error, including its variation with the distance from the center, is in progress.) The right ascensions are affected by quadratic terms that amount to 0″.18 at the extreme corners of the field. The declinations are affected by very small quadratic terms that amount to 0″.04 at the corners. The application of these quadratic terms to the right ascensions reduces the probable value of one difference between the photographic and the meridian circle places from 0″.27 to 0″.26 and leaves for the outstanding photographic errors

± 0″.17 in Right Ascension, ± 0″.15 in Declination.

These do not include the uncertainties in the plate constants. Allowing for these we have for the probable error of a single image on one plate

± 0″.21 in Right Ascension, ± 0″.19 in Declination.

From page 329 of Boss's Preliminary General Catalogue we learn that the probable error of one observation with the meridian circles employed in the compilation of the Astronomische Gesellschaft Catalogue is in the mean 0″.61 in both coördinates.* One observation with the doublet is therefore about as accurate as nine with these instruments. But the various zones of the Gesellschaft Catalogue differ greatly in their accuracy. If we make the comparison with the best four or five of them we conclude that the photographic measures are entitled to about four times the weight, so far as accidental errors are concerned.

On the score of systematic error the present results seem to be superior to zone catalogues compiled by visual methods. Consult the paper by Auwers in *Astronomische Nachrichten* 3842, in which are compared the positions of stars observed in two neighboring zones of the A. G. Catalogue. In spite of the fact that all this work was done upon a uniform plan and that all the zones are based upon the same funda-

* Auwers. A. N. 3844, gives practically the same results.

mental catalogue, systematic differences up to a second of arc are present. This is doubtless due to personal equation in some form, and from this the photographic results are sensibly free. It should be remembered, however, that the photographic results are not only affected by the systematic errors of the fundamental catalogue upon which they are based, but also by possible small systematic errors introduced in the observation of the comparison stars. The same remark applies of course to zone catalogues compiled by exclusively visual methods. It should also be remembered that the use of transit micrometers will undoubtedly yield a considerable increase in accuracy, and had such micrometers been employed for the A. G. Catalogue the right ascensions would have compared more favorably with those of the doublet from the point of view of accidental error as well as of systematic error.

During the progress of the work with the doublet, account was kept of the cost of the various parts of the undertaking. The total cost for one star place (the measurement and reductions giving the right ascension and the declination of a star from one image on one plate) comes to less than fifteen cents. This may be taken as a fair average for the sky; for although the reductions become a little more laborious in higher declinations, experience has indicated, and will indicate, improvements in details and consequent savings of time. This cost does not include overhead charges, the cost of publication, nor the cost of observing the comparison stars with the meridian circle. On the same basis the cost of surveying the whole sky in the same way would be about $80,000, or about the same as the average cost of observing a single zone, embracing 5° in declination, according to the visual methods employed in the construction of the Astronomische Gesellschaft Catalogue. If such a survey is to be undertaken the observing list should include a small number of stars in addition to those in the Gesellschaft Catalogues, these stars being selected to fill up the sparse regions of the sky. There will thus be provided accurate positions of sufficient stars to determine the plate constants of any small-field plates, in particular those of the Astrographic Catalogue. This would strengthen the weakest link in the execution of the Astrographic Catalogue and would considerably enhance its value.

REPORT OF THE COMMITTEE ON METEORS.

By Charles P. Olivier, Secretary.

1a. A radiant shall be determined by not less than four meteors whose projected paths all intersect within a circle of 2° in diameter,

and which are all observed within a period of at most four hours on one night, by one observer.

1b. Or by three meteors on one night and at least two on the next night, seen during the same approximate hours of G. M. T., and all five intersecting as described above.

1c. Or by one stationary meteor.

2a. A radiant shall be considered stationary for the period covered by observations when it fulfils (1a) for four consecutive nights and does not shift its position to an appreciable extent.

2b. Or when it fulfils (2a) for at least five nights or any longer period of time, provided in the latter case new positions are obtained at least every third night, for the whole period of its activity.

3a. A radiant shall be considered in motion or at rest when on examining successive maps of the same observer this radiant shall have moved to an appreciable extent, which from the accuracy of the observations can be considered unmistakable, or in the second place has kept the same position, the conditions being the same.

3b. Under no circumstances shall a meteor be used to determine a radiant point whose projected path passes more than $3\frac{1}{2}^\circ$ from the adopted point, and it is recommended that $2\frac{1}{2}^\circ$ be generally adopted as the usual limit.

4. Three meteors which fulfil (1a) shall be considered enough to give a confirmatory radiant for one determined on the same date of a previous year—i. e. when L, the longitude of the meteoric apex, differs by less than 2°.

5. No radiant shall be included in our future catalogues which does not fall within the above conditions.

6. It is recommended that along with the date, which should be expressed in G. M. T. to tenths of a day, the longitude of the meteoric apex, L, should always be given. Further, that a comparison of radiants in different years should be based upon L rather than upon the date.

7. That the publication in astronomical journals of articles on meteors or notes on their observation be discouraged unless the work shows some semblance of scientific accuracy.

8. That a systematic effort be made to place all branches of meteoric astronomy upon a satisfactory scientific basis. This last can best be effected by prompt criticism, on the part of professional astronomers, of any work published on the subject which obviously lacks scientific accuracy; and further by attempting to unify the terms and definitions used in some such manner as outlined above.

9. It is strongly recommended that immediate steps be taken to secure simultaneous observations of meteors by photography, and that such work be published without delay. This recommendation is based

upon the examination of 25,000 new visual observations of meteors and a careful study of published results, both of which prove that the limit of accuracy has been reached in visual methods, and that these latter are wholly incapable of solving some of the fundamental problems of meteoric astronomy.

REPORT OF THE COMMITTEE ON VARIABLE STARS.

By William Tyler Olcott, Chairman.

During the past year the regular work pursued by the American Association of Variable Star Observers has gone actively forward. To date over 72,000 observations have been contributed by the members of the Association and over two hundred variable stars of long period have been under observation. The light-curves have been drawn by Mr. Leon Campbell of the Harvard College Observatory staff, and all the observations have been published in Popular Astronomy.

Perhaps the most gratifying progress during the past year has been the extension of the work by observers in other countries than the United States. We now have observers coöperating in Italy, Switzerland, Holland, Argentina, and the Hawaian Islands.

The formal organization of the American Association of Variable Star Observers, which will take place at Cambridge, November 10, 1917, will be a step forward in placing this organization on a substantial basis that will greatly enhance its sphere of usefulness. Over fifty observers have signed the proposed Constitution and By-Laws, and a Life Membership Fund has been created the interest from which will be devoted to the purchase of small telescopes to loan to worthy observers. There is great need for such a fund as many observers are lost to science because of their inability to procure adequate observational equipment.

Many suggestions have been made with a view to increase the efficiency of the work of the Association, we already have established a department of chart distribution which provides material as it is required, and arrangements have been made to publish at the end of each year a pamphlet containing all observations contributed to the monthly reports.

Mr. Leon Campbell has kindly offered a number of valuable suggestions concerning the work. These outline the nature of the plans we have in mind to promote the cause. With Mr. Campbell's permission we incorporate these matters in this report. They are as follows:

"The study of variable stars has come to be recognized as a very important branch of astronomical investigation and one in which the amateur, as well as the professional, astronomer can do valuable work.

The field of research has become so extensive that the present time appears to be an opportune occasion to place it on the most efficient basis possible, and plans should be made to coördinate the work in order to avoid unnecessary duplication and also the total neglect of some of the variables. A great mass of good material is being obtained, to be sure, but a more systematic scheme yet seems desirable. It might be well, if the committee was authorized to issue a circular letter, to American astronomers at least, asking what each one is doing in the variable star line, and what he hopes to accomplish therein. This, when studied and, perhaps, printed, would tell at a glance which are the neglected fields, and where more valuable work could be done, that the greatest good may accrue with the least effort expended.

"Also, there are doubtless many telescopes of the larger sizes quite idle, which might be put to good use, if we knew just where they were. The committee could request, in the above circular letter, information as to the location of all telescopes, say of 5-inch aperture, or larger, and the sort of work now being carried on with each.

"The aid of large telescopes, to observe the variables when faint, is a very urgent need. Many of these stars are well enough observed at, or near, maximum, and down to about the thirteenth magtitude. Formerly, the magnitude at maximum and the time of this maximum, appeared to be the only facts sought for, but recent developments show that all the details, including the form of curve at minimum, and to and from maximum, are of equal importance. Already, several of the larger telescopes have been put to this use, including the 16-inch of the Goodsell Observatory and the 26-inch of the Leander McCormick Observatory, and we are assured that a part of the time of the new Victoria 72-inch reflector will be devoted to this work, as well as to the extension of the sequences.

"Some of the variables, as for example the Novae and those of the *U Geminorum* type, during their most rapid variations need attention during each of the twenty-four hours of the day, and this can be accomplished only by having stations widely distributed in longitude and in different cloud regions. Doubtless any new Nova, if discovered in the early part of its career, and sufficiently bright, will be ably taken care of by the already well organized bodies of amateur variable star observers in this country and abroad, but stations in the Western United States and in Asia are greatly needed for their complete investigation.

"Southern stations are also necessary for the study of the southern variables on as extensive a scale as those of the northern sky.

"Frequent cases of suspected variability are being announced, and it seems, if the photographs fail to confirm the variation, from an exam-

ination of twenty plates, or more, that the star should be treated, for a time, as a possible variable, and the burden of proof for its final acceptance as a variable should rest on the discoverer.

"It is safe to assume that the long period variables, at least those reaching the ninth magnitude, or brighter, at maximum, and with a range of three magnitudes, or more, will be fairly well looked after by the American Association of Variable Star Observers. They have made excellent progress in recent years and are continually endeavoring to extend their usefulness in this line of research.

"The variable stars of short period should be as carefully observed as those of the eclipsing type have been at Princeton, Harvard, Mount Wilson, and a few other observatories. This can best be done by modern photometric methods and a number of simple working photometers could be put to good use by experienced observers who can have access to good instruments under clock control.

"The eclipsing variables need still further attention, especially so as regards the occurrence of the times of minimum. Unexplained deviations exist of the observed times of minimum from the computed times, and for those of large range, much valuable work can be done by the experienced variable star observer, using simple visual methods. Those of small range can best be dealt with by photometric means.

"One of the greatest needs of all variable star investigation is the prompt publication of the original observations, in order that the data may be in the hands of the astronomer at an early date. The greatest handicap in referring back to old observations is the lack of the original data from which the astronomers made their deductions."

In conclusion the committee will be glad of suggestions regarding the promotion of variable star observing from members of the Society and expresses its thanks to many professional observers who are coöperating with the A. A. V. S. O. and thus aiding in this important line of astrophysical research.

A SHORT METHOD OF UTILIZING COINCIDENCE OF BEATS IN COMPARING AND SETTING CLOCKS.

CHARLES CLAYTON WYLIE.

(Communicated by Rear Admiral T. B. Howard, U. S. N., Retired, Superintendent U.S. Naval Observatory.)

The method described in this paper of making and reducing chronograph comparisons of clocks running on Standard Time and Sidereal Time is practically what has been developed by the members of the staff of the U. S. Naval Observatory connected with the Time Service. The method of making and reducing comparisons by coincidence of beats was developed by the writer to secure the same simplicity for eye and ear work. Now that the government officials cannot permit private wireless sets with which to receive accurate time from the U. S. Naval Observatory, independent determination of time is of greater value. Perhaps most astronomical observatories have as their best timepiece a Sidereal clock. Some have two good clocks, one a Mean Time, the other a Sidereal. Where there is choice it is preferable to adopt the Sidereal as the standard and set the Mean Time clock by it. The Mean Time can then be kept within a fraction of a second of true Standard Time, and this will help wonderfully in securing the reputation of the observatory as a place of accurate time.

Where a record is desired for scientific purposes, as with the signals sent from this observatory, chronograph work is customary; but practically the same accuracy can be attained by eye and ear. Some results of the writer to test the accuracy of the method give, as the probable error of a single comparison by coincidence of beats, ± 0.008 seconds. The probable error of a setting by coincidence seems to be about twice that of a comparison. It is doubtful if the performance of many clocks warrants the expenditure of much care to reach even this accuracy. To ascertain the advantage of the method of reduction here presented, the writer, with Mr. Ernest Clare Bower of this observatory, prepared and reduced a number of comparisons by coincidence of beats, both as ordinarily taken and as suggested in this paper. The average time for reduction by the short method was 45% of the average time for reduction by the regular methods. In practice the reduction of a comparison by coincidence may often be practically completed while waiting for the coincidence to occur.

COMPARISONS BY CHRONOGRAPH.

Let us consider the following example:—On 1917 February 10.9 at the U. S. Naval Observatory, Seth Thomas clock No. 100 keeping Eastern Standard Time was compared with Howard clock No. 404 keeping Local Sidereal Time, by chronograph, as follows:—Seth Thomas 23 hr. 33 min. 0.00 sec. = Howard 20 hr. 49 min. 40.95 sec. The correction to Howard No. 404 was −15.06 sec. Find the correction to Seth Thomas No. 100.

A good explanation of the usual method of reduction can be found in Campbell's Practical Astronomy page 22. We will modify this somewhat:

			h	m	s	
(1)	(a)	Greenwich Sidereal Time Mean Noon February 11,	21	23	54.47	
	(b)	Change in 5h. Table III,			49.28	
	(c)	75th Meridian Sidereal Time of 75th Meridian Mean Noon,	21	24	43.75	(c=a+b)
	(d)	Longitude Washington from 75th Meridian,		8	15.78	
	(e)	Washington Sidereal Time of 75th Meridian Mean Noon,	21	16	27.97	(e=c−d)
	(f)	Correction to Howard, No. 404,			−15.06	
	(g)	Howard No. 404 Time of 75th Meridian Mean Noon,	21	16	43.03	(g=e−f)
	(h)	Given Howard Sidereal Time,	20	49	40.95	
	(i)	Mean Time interval to Seth Thomas Noon,		27	0.00	
	(k)	Table III, argument 27 min.,			4.44	
	(m)	Howard No. 404 Time of Seth Thomas Noon,	21	16	45.39	(m=h+i+k)
	(g)	Howard No. 404 Time of 75th Meridian Mean Noon,	21	16	43.03	(see above)
	(n)	Correction to Seth Thomas,			+ 2.36	(n=m−g)

In looking at the reduction we see that (b) and (d) are constant for any particular observatory, and may be combined to obtain (e) in one operation. This quantity should be obtained and kept for use whenever clocks are compared. It is the reduction to apply to *Greenwich Sidereal Time of Mean Noon*, to obtain *Local Sidereal Time of Standard Time Noon.* For the Naval Observatory this quantity is − 7 min. 26.50 sec. Though it is not obtained in the above problem it will be obvious to the reader that for a given place the reduction to apply to Greenwich Sidereal Time of Mean Noon to obtain the Local Sidereal Time of any hour of Standard Time is constant. For example, the reduction for 10 P. M. at this observatory is + 9 hr. 54 min. 12.07 sec. So for simplicity in reduction as well as in carrying forward clock rates the comparisons should be made at about the same time each day. If 11 A. M. to Noon is convenient, keep the reduction to Local Sidereal

Time of Noon. If 8 A. M. to 9 A. M. is more convenient, obtain and preserve for use the reduction to Local Sidereal Time of 9 A. M.

By taking comparisons always on the beginning of a minute of the Standard Time clock the only part of Table III utilized, after obtaining reduction mentioned in preceding paragraph, is the first column. We see also that with this form of reduction the column of seconds is not affected by dropping the work for the minutes and hours. The correction is generally known to be only a few seconds—usually the minute can be checked by comparing with another Standard Time clock. By these considerations we condense the work to the following:

(2)	(a)	Greenwich Sidereal Time Mean Noon February 11,	54.47
	(b+d)	Reduction to Washington Sidereal Time of 75th Meridian Mean Noon,	−26.50
	(e)	Washington Sidereal Time of 75th Meridian Mean Noon,	27.97
	(f)	Correction to Howard No. 404,	−15.06
	(g)	Howard No. 404 Time of 75th Meridian Mean Noon,	43.03
	(h)	Given Howard Sidereal Time,	40.95
	(k)	Table III, argument 27 minutes,	+ 4.44
	(m)	Howard No. 404 Time of Seth Thomas Noon,	45.39
	(g)	Howard No. 404 Time of 75th Meridian Mean Noon,	43.03
	(n)	Correction to Seth Thomas,	+ 2.36

Where daily comparisons are made the quantity (e), or its equivalent the Sidereal Time of the proper Standard Time hour, may be entered months ahead. Several months may be entered from the Ephemeris in a few moments. If a copy of the first column of Table III is kept handy on a small piece of cardboard or heavy paper it will be unnecessary to open an Ephemeris in making and reducing a comparison. It is obvious that, having obtained the quantity (g), several Mean Time clocks may be compared or several comparisons of the same one made with slight additional labor. The reduction after this point is hardly more than a mental process.

Comparisons by Eye and Ear.

Where a high degree of accuracy is not sought, an eye and ear comparison is made by noting the second and estimated tenth of second the Sidereal clock reads on the beginning of a minute of the Standard Time clock, or when the latter reads zero seconds. The reductions are made as with chronograph work, (see form (2)), but only to the tenth of second. Where greater accuracy is desired the reading of the Standard Time clock at time of coincidence of beats with the Sidereal is

also taken. To understand the method of reduction suggested, see form (1), and consider the quantities (h), (i), (k), and (m). In general when

(h) = Reading of Sidereal clock at time of comparison,
(i) = Mean Time interval to next hour by Mean Time clock,
(k) = Table III, argument (i),
(m) = Reading of Sidereal clock at the next hour by Mean Time clock,

we may say, neglecting the rates of the two clocks,

$$(h) + (i) + (k) = (m).$$

Now if the clocks are in exact coincidence the decimal of second of the quantities (h) and (i) must be zero. The decimal of second of (m) must therefore be identical with that of (k), the quantity from Table III. We may then obtain the value of (m) more accurately by noting the reading of the Standard Time clock at time of coincidence, forming the interval to next hour, and with this as argument entering Table III for the decimal part of (m).

The following example will illustrate the method of comparing and reducing when the accuracy of coincidence of beats is desired:—An observatory, Longitude West 6 hr. 9 min. 18.33 sec., has a clock running on Local Sidereal Time, and two clocks, Clock A and Clock B, running on Central Standard Time. The clocks are compared between 8 A. M. and 9 A. M. and the constant reduction from Greenwich Sidereal Time of Mean Noon to Local Sidereal Time of Central Standard Time 9 A.M. (or 21 hr.) is + 20 hr. 55 min. 7.80 sec. On 1917 July 4.9 the correction to the Sidereal clock is − 30.41 seconds and

M. T.	A	30 min. 0.0 seconds	= Sidereal 13.8 seconds.
M. T.	B	31 min. 0.0 seconds	= Sidereal 16.1 seconds.
M. T.	A	Coincidence with	Sidereal = 31 min. 6 sec.
M. T.	B	Coincidence with	Sidereal = 30 min. 15 sec.

Find corrections to Mean Time clocks A and B.

(3)		Clock A	Clock B
(a)	Greenwich Sid. Time Mean Noon July 4,	41.88	
(b+d)	Reduction to Local Sid. Time of C. S. T. 9 A. M.,	+ 7.80	
(e)	Local Sid. Time of C. S. T. 9 A. M.,	49.68	
(f)	Correction to Sid. Clock,	−30.41	
(g)	Sid. Clock Time of C. S. T. 9 A. M.,	20.09	
(h)	Given Sid. Clock Time,	13.8	16.1
(k)	Table III, (30 m),	4.9	(29m) 4.8
(m)	Sid. Clock Time of Clock 9 A. M.,	(18.7)	(20.9)
		18.75	20.89
(g)	Sid. Clock Time of C. S. T. 9 A. M.,	20.09	20.09
(n)	Correction to M. T. Clocks,	− 1.34	+ 0.80

Up to step (m) the reductions are made as for chronograph comparisons, (see form (2)), but only to one decimal in steps (h), (k) and (m). This rough value of (m) is bracketed and the more exact value obtained from Table III. The times of coincidence are, for Clock A 31 min. 6 sec., and for Clock B 30 min. 15 sec.; so we enter the table with arguments 28 min. 54 sec. and 29 min 45 sec., thereby obtaining the decimals .75 and .89 which are entered in place of the values in brackets. No attention is paid to the whole number of seconds in the table as that is already known.

Setting A Clock.

When comparisons are taken on the chronograph one can change the correction of a clock by causing the pendulum to swing more rapidly or more slowly as may be necessary. An expert, finding a clock a tenth of a second in error either way, can thus correct it by hand so that repeated comparisons show the hundredth of second as desired. But quick setting in this manner requires a certain amount of natural skill and considerable practice. The clocks used for sending out the Naval Observatory Time Signals are each equipped with an electromagnetic setting device. A permanent magnet attached to the pendulum swings over a solenoid. A current in one direction through the solenoid will attract the magnet, and in the reverse direction will repel the magnet. By this device the clock can be given a gaining or losing rate of about 0.05 seconds per minute; so that, for example, an error of 0.15 seconds can be corrected in three minutes.

For those with no special device for setting, a simple and accurate way of getting a clock on true Standard Time is suggested by the method of comparing by coincidence of beats described earlier in this paper. Set the Mean Time clock so that the beginning of its minute comes at the proper second by the Sidereal clock. The fraction of the second may be made nearly correct by estimating the reading of the Sidereal at the zero second of the Mean Time.

If an accurate setting is desired this is accomplished by putting the Mean Time clock in exact coincidence with the Sidereal at the proper time. For example let us suppose it is desired to set the clocks of form (3). The reduction gave for the Sidereal clock time of C. S. T. 9 A. M., 20.09 seconds. By Table III and subtraction we get

for C. S. T. 8 hr. 34 min. A. M. a Sidereal clock reading of 15.8 sec.,
for C. S. T. 8 hr. 35 min. a Sidereal clock reading of 16.0 sec ,
for C. S. T. 8 hr. 36 min. a Sidereal clock reading of 16.1 sec.

For those minutes just after we have taken the comparisons recorded earlier in this paper the second hands of the Mean Time clocks should

read 0.0 when the second hand of the Sidereal reads about 16.0. To set, hold Clock A back about a second to approximate coincidence with the Sidereal, and accelerate Clock B about a second, also to approximate coincidence. If this is done with ordinary care they will now be correct within one or two tenths of a second. For .09 we obtain by interpolation from the first column of Table III, a coincidence at 35 minutes 6 seconds, and another at 41 minutes 11 seconds. One Mean Time clock may be carefully put in coincidence at 35 minutes 6 seconds, if ready then; or if not, at 41 minutes 11 seconds. When it is accurately set the other Mean Time can be set in coincidence with it. It is unnecessary to set both by the Sidereal, though that may be done and the two Mean Times then compared with one another as a check on the accuracy of the work.

General Remarks.

The details of the operations have been outlined in the preceding paragraphs, and some general notes which may be found useful will be added here. The first column of Table III of the Ephemeris is constantly used in the methods of this paper. Since it is the only part of the Ephemeris ordinarily used it should be copied in convenient form. Using the Table as in the Ephemeris one looks up a correction with the number of minutes until the next hour as argument. It has been found more convenient to have as argument the face reading of the clock at time of comparison. That is, if a comparison be taken at 23 hr. 35 min., one would look in Table III of the Ephemeris under 25 minutes. In our table we take out the correction with argument 35 minutes, the face reading of the clock. The face reading table is especially convenient in coincidence work, where the argument includes both minutes and seconds. It may be added that the third decimal is dropped in the copies of the table in use here. This paper has been prepared with the Table III arguments as given in the Ephemeris to avoid confusing the reader.

A theoretical objection to this method of comparison is that it gives the correction to a Mean Time clock in terms of Sidereal seconds. This can of course be allowed for, but the error introduced is less than a hundredth of a second, for a clock correction of three seconds, and, those interested in high accuracy will probably keep the correction well below that by setting and regulating. This objection does not apply to the method of setting suggested, as the correction to the Mean Time clock is not used.

It may also be remarked that frequent setting of a clock by the method of coincidence will be found simpler and more satisfactory than the method, quite generally practiced a few years ago, of keeping the

clock approximately correct without setting, by adding to or removing from the pendulum small weights. Many members of the staff of this observatory have in former years used that method of keeping a clock on the correct time, but none now do. It keeps the rate of a clock variable and somewhat uncertain. The standard clocks here, sealed and in a constant temperature vault, are, in general, disturbed only for cleaning; but a dozen other high grade clocks, both Sidereal and Mean Time which show accurate time over the institution are frequently set. Setting a clock appears to have no appreciable effect on its rate provided one is careful to leave the pendulum swinging at its normal amplitude. An abnormal amplitude may cause an abnormal rate, until the pendulum returns to its normal amplitude.

In conclusion we give some settings of a Mean Time clock made by Mr. C. B. Watts of this observatory to test the accuracy of the coincidence method. The procedure was to get the Mean Time clock beating as accurately as possible in coincidence with the Sidereal at the proper time to give the "indicated" reading. In a minute to a minute and a half the two clocks would be sufficiently out of beat to permit comparison on the chronograph. A comparison was then made and the "recorded" reading obtained. The difference between the "indicated" reading, at which it was attempted to set the clock, and the "recorded" reading which the comparison on the chronograph showed, was taken as the error of that setting. These settings were made on the afternoon of 1917 October 9. Only the decimal of the second is given.

Indicated	Recorded	Error	Indicated	Recorded	Error
.97 sec.	.96 sec.	.01 sec.	.31 sec.	.30 sec.	.01 sec.
.82	.79	.03	.33	.32	.01
.53	.54	.01	.04	.01	.03
.13	.13	.00	.72	.73	.01
.23	.27	.04	.83	.85	.02

These results give as the probable error of a single setting by coincidence, ± 0.015 seconds. Errors in the record, in the running of the chronograph, in the break circuit wheels of the clocks, etc., cause a probable error in a single comparison of the clocks used of about ± 0.006 seconds. This probable error is included in that given above for a single setting by coincidence.

U. S. Naval Observatory, Washington, D.C.
1917 October 15.

A REPLY TO PROFESSOR FLINT'S ARTICLE, "THE AMERICAN EPHEMERIS TABLES OF THE TIMES OF RISING AND SETTING OF THE SUN AND THE MOON.—A REVIEW."

ARTHUR NEWTON.

(Communicated by Rear Admiral Thomas B. Howard, U. S. Navy, Superintendent U. S. Naval Observatory.)

The following communication was prepared at the suggestion of the Director of the Nautical Almanac who desires to express his appreciation of the elaborate review by Professor Albert S. Flint which appeared in the October number of POPULAR ASTRONOMY. The review dealt with the new Ephemeris Tables for determining the times of rising and setting of the sun and moon at any place between Lat. 60° S. and Lat. 60° N. These tables are issued in separate form for the years 1917 and 1918, the two years in a single pamphlet. For subsequent years the tables will be incorporated both in the Nautical Almanac and in the American Ephemeris. There are a few points in the review to which exception must be taken:

(a) The reviewer labors under a misapprehension in stating that the tables are for the moon's center on the horizon. For both sun and moon, the tables give the instant when the upper limb is on the horizon. This is in accordance with Chauvenet and Young; and also with the German Ephemeris which states its practice in a rather inconspicuous place. Beginning with the Nautical Almanac for 1919 and the American Ephemeris for 1920, a statement on this point is inserted at the top of each page of the tables.

(b) A further misapprehension appears from the statement in the review that the computer of Table III seems to have neglected parallax and refraction. Now, the fact is that the actual parallax at the time of each phenomenon is used; while 50′ is the constant adopted for both sun and moon to represent the combined effect of refraction and semi-diameter. Dip is neglected, since the horizon of the tables is the sensible horizon, or horizontal plane passing through the observer's eye.

(c) The reviewer has construed the precept given with Table II, in a way not intended. Table II is to be entered first, and then Table I; whereas the reviewer understands that Table I is to be entered first. Moreover, the whole idea of using Table II is disapproved as not being in line with what is done in case of the moon. The reason why a different plan is used in case of the sun is that a small but unmistakable

gain in accuracy has been secured thereby. The method suggested by the reviewer would necessitate placing at the head of the last column of the year in Table I a correction of 19^m for sunrise and sunset to be used on all dates in that column; but this would introduce on some of those dates an error of 2^m, since the true correction for that column ranges from 17^m to 21^m.

(d) In adapting the example to his own method for southern latitudes, the reviewer has apparently made a slip of one day in getting sunrise at the southern station. Had he entered Table I with May 9, his final result should have been in exact accordance with that obtained in the Ephemeris publication.

(e) The reviewer refers to an article by himself in Popular Astronomy, No. 185, Vol. XIX. One erratum in that article is to be noted. On page 269, the precept reads: $t' = t + t \times H.D.$ (2) But in an addendum, the reader is told that this should read: $t' = t + t' \times H.D.$ (2); and that the accent was dropped through a typographical error. It so happens that the first form is correct; the expressions that follow, involving t_o'', ought to be omitted from the precept. This is the explanation for the discrepancy that puzzled Professor Flint,—a discrepancy in the results from two different methods as applied in an example in the same article.

(f) The most serious count against the tables, as set forth in the review, is that they require a systematic correction of three to thirteen minutes. This criticism we believe to be unjust. Since their publication, the moonrise and moonset tables for 1917 have been compared with the less extensive tables given in the 1917 Berliner Jahrbuch; the German and American tables were computed quite independently of each other, but their mutual agreement in those latitudes to which both apply is well-nigh perfect. The reviewer is of opinion that in Lat. 54° the tabular values should be increased 8^m for moonrise and decreased 8^m for moonset. Comparison with the Jahrbuch throughout the year gives for Lat. 54° a mean correction of $0^m.00$ to be applied to the American tables for moonrise and $-0^m.08$ for moonset. In fact, the tables for moonrise and moonset are good for places north of the equator without any correction whatever; this refers, of course, to moderate elevation above the sea and mean atmospheric conditions; and also, as previously stated, to moon's upper limb on the sensible horizon. For places south of the equator a correction ought, theoretically, to be applied; but this correction is so small as to have been deemed negligible, at least for the ten year period, 1917 to 1927. From 1927 to 1937, when the moon's declination reaches extreme limits, it may become necessary to apply a correction, but only for places south of the equator.

NOTE—The superintendent of the U. S. Naval Observatory has kindly sent me in advance a copy of the preceding reply, and I desire to append the following note.

The principal points of the reply are well taken, and I regret especially my erroneous conclusions and suggestions, as presented in the upper part of page 509, as unjust to the authority for the tables. I had it firmly fixed in mind that the center of the moon's disk was the point of reference commonly taken. There certainly are two logical reasons for this: the popular reason that the rising moon is not conspicuous at the first appearance of the edge of the disk, and the technical reason that the center of astronomical objects of appreciable apparent magnitude is commonly taken as the point of reference. I had overlooked Chauvenet's and Young's remark. I computed originally a number of examples to compare with the tables; but the misconception as to the point of reference was a source of some difference at the outset, especially for the high latitudes, and my computations must also have been in error at places. I took an average of several results in conclusion. I suppose I had a lurking feeling that the moon was too troublesome a body to be given extensive consideration. I have recomputed a few of the tabular numbers and agree closely with them. Of course the tables, computed so carefully as they have been at the Washington office, must be practically correct.

I may be permitted to add a few words as to minor points.

My fault at page 508, beginning of the third paragraph, is only a superfluity. There would simply be no use for the time obtained from Table I in accordance with the first suggestion. If one omits the second line, all but the first word "reader", and all of the third line, except "Table II" at its close, the paragraph reads well and is correct.

In the example at the top of page 512 I hold the dates to be all correct. But apparently in putting down the time of sunset for the northern station, 1917, May 9, I repeated the time $6^h\ 59^m$ by mistake from the preceding example instead of looking it out anew from Table I. It should read "Sunset, May 9, $6^h\ 58^m$", which agrees exactly with the example in the published tables.

I take this opportunity to make a change at page 511 second paragraph, second line. For the loose phrase "in accordance with the preceding" substitute the following: "for the opposite, northern, station." Also, at the beginning of the last line but one of this division "*For South Latitudes*", read "For both sun and moon add twelve hours etc".

ALBERT S. FLINT.

Washburn Observatory,
Madison, Wisconsin.
December 11, 1917.

REPORT ON MARS, No. 19.

WILLIAM H. PICKERING.

This Report will be devoted mainly to a consideration of certain recent views regarding the nature of the so-called canals, but first we must briefly consider an interesting application of Green's Tetrahedral Theory of the Earth to the planet Mars, suggested by our associate Dr. Lau (A. N. 4878, **204**, 122). Briefly stated, this theory is that in a slowly contracting sphere with a solid surface, the shape which would permit of the greatest contraction of volume with the least contraction of surface is the tetrahedron. Therefore the contracting planet should, while retaining a nearly spherical shape, tend to exhibit four equidistant protuberances and four intermediate flattened surfaces. Dr. Lau places one protuberance at the north pole, and the corresponding surface opposite it at the south. The other three protuberances should then be in latitude $-20°$, and the centers of the other three surfaces in latitude $+20°$. These three surfaces Lau identifies as Acidalium, mean latitude $+43°.5$; Propontis, latitude $+35°.0$; and Utopia, latitude $+34°.5$.

We naturally cannot demand that an exactly geometrical form be produced, and a reasonable deviation from it may be expected, but these deviations, while all of them rather large, have the serious defect that they all lie in the same direction, too far to the north, and are therefore located too near together. The three darkest spots on the planet near latitude $+20°$, and which we have reason to believe are really depressions, are Lunae Lacus, latitude $+19°$ longitude 65°; Trivium Charontis, latitude $+17°$ longitude 195°; and the marsh in the Syrtis Major, latitude $+14°$ longitude 285°. If we locate the theoretical centers of the three dark areas at longitudes 60°, 180° and 300°, then the three deviations will be $+5°$, $+15°$, and $-15°$.

The three depressed regions suggested by Dr. Lau lie slightly to the east of those above indicated, and seem to be way stations to them, the current of moisture in each case curving westerly as it travels southward. While the deviations that we have found are not excessive, the theory does explain, as pointed out by Dr. Lau, the existence of the depression and consequent dark areas in the southern hemisphere, and the existence of the three routes traversed by the moisture on its way from the north pole through the depressed areas to that hemisphere.

The statement is often made that the canals always follow the course of great circles. It is possible that this is occasionally true, but it is certain that it is by no means usually the case. The great majority that are well seen are obviously curved. Most of the remainder are either too broad or too short to make any accurate statement possible. A few others seem to be straight for a portion of their course, and a very few indeed among the fainter ones seem to exhibit no deviation for hundreds of miles. What is rather striking is that several of these latter follow an approximately meridional course. Some of the others follow for considerable distances along parallels of latitude, thus describing arcs of small circles. These latter are generally found in northern latitudes and are associated with the snow cap.

The surface of Mars is extremely level as compared with that of our Earth, and it is not believed that the canals lie in hollowed out channels upon its surface, but rather that they are simply marshes deposited as the result of the passage of heavy rain storms occurring at night. The more permanent tropical ones may in some cases support vegetation. In the night time the rare atmosphere of Mars would permit a considerable fall of temperature, and if well saturated with moisture, heavy showers should ensue. In Jamaica our tropical showers are often very heavy, and their edges very marked. Thus on several occasions we have observed it to be raining quite sharply on one side of our house, and not raining at all on the other. The showers vary from a fraction of a mile up to several miles in diameter, and traverse the island from east to west. If instead of a rich tropical vegetation, the country presented nothing but a barren sandy plain, which we could view from a sufficient elevation, the track of each shower would appear to us as a straight narrow dark band of fairly uniform width. Supposing now the Martian canals to be due to this cause, let us next see what courses we should expect them to follow, for it is clear that they could not pursue a straight line for any very great distance on account of the rotation of the planet.

Before starting in on this investigation, however, we will begin by investigating something quite different. We all know that a frictionless marble acted on only by gravity, if projected across a level surface, will continue to move forever in a straight line with uniform velocity. If projected upon the surface of a stationary sphere, gravity acting towards its center, the marble will describe a great circle with uniform velocity. It cannot under any circumstances describe a small circle. If the sphere revolve. the marble can only continue to trace a great circle in case its velocity is infinite. If it is finite the marble will follow a curve, which if confined to one hemisphere will consist of a series of loops resembling an epicycloid. These will be executed at

uniform velocity along some given parallel of latitude dependent upon the speed, the marble being constantly deflected to one side of its course in such a manner that for most of the time the curve will lie between the parallel and the equator. In the case of the Earth the general direction of motion of the marble will be towards the west for either hemisphere, quite regardless of the direction in which it was originally projected. If given sufficient speed the marble will cross back and forth across the equator, and may then go either towards the west or towards the east. If projected towards the east, it will maintain that direction, following a sinusoidal curve. This proposition may be demonstrated indirectly by the Foucault pendulum.

It must be understood that it is the absolute velocity of the marble that is uniform, and that relatively to the motion of the surface of the the sphere in different latitudes it will vary. In Figure 1 let E S W N represent the Earth, or the planet Mars, the arrowhead at the center

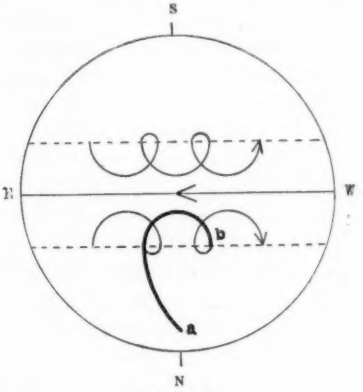


FIGURE 1.

indicating the direction of its rotation. Then the two curved lines will represent the course which the marble must follow in either hemisphere, if it moves at only a moderate velocity. If the marble starts near the pole, and moves with a rapidly diminishing velocity, it will follow some course such as *a b*.

Turning now from the case of the marble to quite a different subject, the velocity of the wind, we know that if atmospheric air is admitted at sea level into a perfect vacuum it will attain a maximum velocity of 950 feet per second, or 648 miles per hour. It is theoretically impossible for any wind at the Earth's surface to be higher than this, and at great elevations this velocity must be considerably reduced. The highest wind velocity ever recorded at the surface of the earth is 185 miles per hour, measured by the Weather Bureau on Mt. Washington, in

the White Mountains of New Hampshire, altitude 6290 feet. A speed of 230 miles per hour has however been recorded for some of the higher clouds at the Observatory on Blue Hill, near Boston. The higher clouds float in general at an altitude of six to nine miles. At seven miles the atmospheric pressure is reduced to one quarter of that at sea-level, and the maximum possible velocity of the wind to one-half, or 324 miles. We thus reach the rather surprising result that at these altitudes the observed velocities occasionally reach two-thirds of the possible theoretical maximum.

Having now stated some of our fundamental facts and theorems, we will next turn to the meteorology of our Earth. We know from observation that there is a band along the equator where the barometer is permanently low caused by the heat of the Sun, that there is an irregular band on either side of it, most uniform in the southern hemisphere, and located in latitude 30°, where it is permanently high, and that near the poles it is again permanently low. At the south pole itself there is a high barometer. Over the oceans the equatorial band is known as the doldrums. Here the air is constantly rising, producing a cloudy sky, rains and calm weather, disturbed only by local squalls. The two belts where the barometer is high are known as the horse latitudes. Here the air is constantly descending, producing cloudless skies and generally calm weather. The writer has found that the best location for an astronomical observatory, as far as atmospheric conditions are concerned, is on the equatorial side of these belts.

If we consider these regions of high barometer as hills, then in the northern hemisphere our marble dropped down on the southern side of them would roll towards the equator, being apparently deflected, however, by the Earth's rotation towards the west. If it were dropped on the northern side of them it would roll towards the pole, but be deflected at first towards the east. All these belts shift a few degrees north and south with the change in declination of the Sun. It will be observed that what we may call the heart of the terrestrial circulation, its driving motor, is located in the doldrums along the equator, where the Sun's heat starts the upward currents in our atmosphere which keep the whole of it in motion.

On Mars, where there are no permanent oceans, the case is different. There must be a belt of low pressure along the equator as in the case of the Earth, but since the atmosphere of Mars consists very largely of water vapor, which is generated by the melting of the snow at the summer pole and removed from the atmosphere by condensation at the pole where it is winter, we must necessarily have a marked high barometer in the spring time at the pole where the vapor is generated, and marked low at the pole where it is condensed. The barometric

gradients must be steeper in proportion to the deflective force of the planet's rotation than on the Earth, and the winds lie in a more nearly north and south direction. The steepness of the gradients will be especially marked on the night side of the planet in the hemisphere where the snow is melting.

Let us now imagine a rain storm on Mars starting in a northern latitude in the spring of the year, and gliding down the steep barometric gradients upon the night side towards the equator, with an ever increasing speed, accelerated both by the force of gravity and by the rush of vapor generated from the melting polar cap. Soon the retardation due to friction with the rest of the atmosphere will reduce this acceleration, and before long it will become zero. While this condition continues the velocity of translation of the storm will be constant, and the case similar to that of our frictionless marble. Assuming the broad curving canals leading southward from the polar cap to be marshes fed by storms, the problem to be solved is to determine the direction of motion, and the speed of the storm, that will trace out one of these marshes. Figures 2, 3, 4, and 5 are copied from Figures 6, 14, 18 and 22 of Report No. 17. On each figure is marked the central meridian,

FIGURE 2.

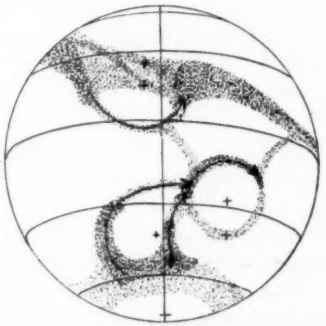


FIGURE 3.

the north pole, the equator, and the parallels of 30° and 60°. On the main curving canals are drawn arcs of circles, coinciding as nearly with them as possible, and from the direction of their curvature and its radius, the direction and velocity of the corresponding storm is computed. The direction is indicated in each case by an arrowhead, the center of curvature by a small cross, or when it changes by two crosses.

Let V be the velocity of the wind in the canal, R the observed radius of curvature, r the computed radius of curvature for a wind blowing one mile per hour, ϕ the latitude of the selected point where

the velocity is to be measured, and 24.62 the sidereal period of Mars expressed in terrestrial mean time hours. Then

$$r = 24.62/2\pi\sin\phi \text{ and } V = R/r = 2\pi R\sin\phi/24.62.$$

The longest radius of curvature, and the highest corresponding velocity of the wind in any of these southward leading polar canals, is found in the northern portion of Casius-Thoth, Figure 5, shortly after the storm has started from the Boreosyrtis region. The distance from the little cross near the center of the figure to the middle of the canal where it crosses latitude $+35°$ is 1572 miles. Dividing this by 6.83, the computed value of r for this latitude, gives us a velocity of 230 miles per hour.

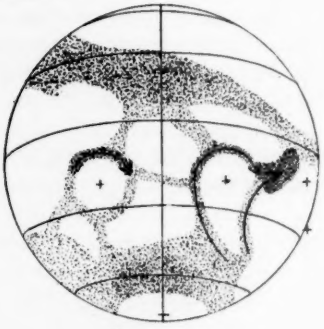


FIGURE 4.

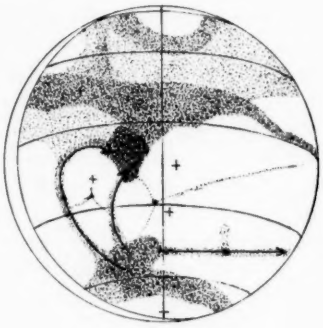


FIGURE 5.

But the speed is really somewhat higher than this, since Thoth is not located on the central meridian and part of the curvature is due to this cause. In Figure 4 where it is more nearly central, and the meridians curve in the other direction, the speed appears to be 222 miles per hour. There is another correction to be made to these figures however. The computation is made for a frictionless storm, or more accurately speaking for a storm where the acceleration is balanced by the friction, and the velocity is constant. If the acceleration is in excess it tends to straighten the path, if the friction is in excess it tends to curve it. This effect is seen farther south, where in Nepenthes in latitude 10° the radius of curvature is reduced to 426 miles, and dividing this by 22. 57 gives us a velocity for the wind of only 19 miles per hour. The velocity of the storm at the beginning of its course, where it was first expelled from the polar regions, was probably somewhat less than 230 miles per hour, and towards the end rather more than 19.

Let us assume now, however, that the wind on Mars in the north temperate zone does sometimes reach a velocity of 230 miles per hour,

or the same as that observed for the upper clouds near Boston. Then the maximum theoretical velocity cannot be much less than 324 miles, nor the corresponding pressure less than one quarter of a terrestrial atmosphere, or 7.5 inches of mercury. From various considerations, such as the small force of gravity on Mars, the small bulk of its snow caps, the transparency of its atmosphere, and the lack of permanent oceans, we conclude that the maximum possible value of the pressure cannot be very far above this figure. The boiling point of water upon Mars must therefore be approximately 150°F (66° C), and cannot be much lower. While these results can lay no claim to great accuracy, it is satisfactory to have at last got beyond the point of mere guesses at this important figure.

If now the density of the atmosphere of Mars is one quarter that of the Earth's, the pressure exerted by a wind of 230 miles an hour would be no greater than that of a terrestrial storm blowing at the rate of 115 miles. But a mean velocity of 102 miles for an interval of over five minutes has been recorded by the Weather Bureau at St. Paul, Minnesota, so it would appear that the effect of Martian storms may be no more severe than our own. It must moreover be remembered that the climate of Mars is one of extremes. It has no great oceans or dense atmosphere to modify its surface temperature, which must be subject to a great daily range. The relative atmospheric pressure when dry and when saturated with moisture must have a great range also when compared with our own. These extremes of temperature and pressure must both tend to produce high winds, while on the other hand the rarity of the atmosphere would offer little resistance to reduce their velocity. Our result is therefore no higher than we might reasonably expect.

On the other hand the case of Thoth seems to be rather an exceptional one. It is by no means a permanent canal. Its appearances are sporadic, appearing for a few years in succession, after which it may not be seen again for several years at a time. It together with Nilosyrtis serves to fill the Syrtis marsh, the only large area remote from the polar caps where conspicuous floods occur. This of itself implies the transmission of large quantities of water, but besides this, Thoth is the only one of the five chief polar canals that succeeds in forcing its way into the torrid zone. The other four stop when the tropic is reached, and we might therefore naturally expect that their curvatures would indicate lower velocities. The incursion of Thoth into the tropics results as we have seen in a great reduction in the original velocity, clearly due to atmospheric friction.

TABLE I.

VELOCITY OF THE WINDS ON MARS.

Fig.	Name	Lat.	*r*	*R*	Vel.
2	Acidalium	60	4.53	586	129
"	"	35	6.83	959	140
3	Eumenides	—5	44.97	853	19
"	Gigas	—5	44.97	560	12
"	Brontes	45	5.54	694	125
"	Erebus	25	9.29	986	106
"	Hades	40	6.10	773	127
"	Cerberus	12	18.85	533	28
4	Cerberus	10	22.57	426	19
"	Casius-Thoth	35	6.83	1518	222
"	Nepenthes	10	22.57	426	19
"	Nilosyrtis	30	7.84	853	109
5	Casius-Thoth	35	6.83	1572	230
"	Nepenthes	10	22.57	426	19
"	Nilosyrtis	30	7.84	773	99

Each one of the other canals retains nearly its original velocity as far as the tropic. Thus Acidalium, as shown by the last column of Table I, begins with a velocity of 129 miles and ends with one of 140, that is to say it is practically constant. The other columns refer to the Figure, the parallel of latitude where the measurement is made, the computed radius *r*, and the measured radius of curvature expressed in miles. The velocity of the wind in the canal Brontes, in Figure 3, soon after leaving the Propontis region is 125 miles, and in its continuation Erebus 106. In Hades it is 127. Cerberus is not a polar canal, since it starts in the Trivium Charontis. Two determinations of its velocity were made, and the highest, 28 miles, is probably correct, since in Figure 4 the circular area Elysium is certainly drawn too small. Two determinations of the speed in Nilosyrtis were made. On account of the curvature of the meridians it must be rather less than 109 miles, as judged by Figure 4, and rather more than 99 miles as judged by Figure 5. All of these velocities are materially less than that in Thoth. A comparison of these drawings with those of the other observers given in Report No. 17 shows that they would yield similar results for these canals. Since these six canals are all located in the northern hemisphere they must necessarily all curve to the right, and consequently as we see they all lead away from the pole. This is indicated by their arrowheads.

If the velocity of the Martian winds is due in part to an excess of atmospheric pressure, caused by the evaporated moisture of the polar cap, then as the cap diminishes in area we should expect less moisture to be evaporated, and consequently that the velocity of the wind and the radius of curvature of the canals would diminish, the canals shifting

their positions to that extent. If we turn to Report No. 7 we shall find a series of drawings of the region of the Syrtis major, each drawing being the best obtainable, and representing the appearance of the formation for every opposition extending from 1877 to 1914. Below the terrestrial date the equivalent Martian Date is given in each case. The revised Martian calendar did not appear until somewhat later, but the deviation from the revised date is in no case very great. Among the earlier drawings the longest radius of curvature, that is, the straightest representation of the Syrtis and the highest wind velocity, is that for 1882, March 13. The equivalent Martian date is given as May 2, and on the revised calendar it would be April 35. At this season the polar cap was melting very rapidly. In the two previous drawings it had hardly begun to melt, but in those that follow, as the Martian season progressed, we see the Syrtis gradually curling up, until in 1894 its northern extension had entirely disappeared. Although faint, it is comparatively straight again in 1897, Martian date April 27. It again curls up in the drawings that follow, and its extension disappears in 1905. It reappears in 1907 and 1911. In the latter year the snow has only just begun to melt, but the sharp curvature is in part also due to the proximity of the limb. In 1913 and in Figure 5 of the present article it has straightened appreciably, and as the polar cap diminishes in size this next year and the wind dies down, we again expect to see it curl up and assume a shorter radius of curvarure.

But besides these polar canals or marshes, certain others are shown, which do not follow in the track of the polar winds. Cerberus, already mentioned, is one of these. Those marshes completing the circuit of Elysium in Figures 3 and 4 probably indicate merely a continuation of this wind whirl. The northern side of Elysium is extremely faint, and a careful search should be made this year to see if its radius of curvature is smaller than on the south side as it should be, and as appears from these drawings to be the case. The canal due north of Elysium shown in Figure 4, and lying between Aesacus and Anian upon our standard map, Report No. 15, does not appear on the drawings of either of the other observers, and was seen only twice by the writer. Like the other canals branching from Elysium in various directions, which are not always seen, and which are often quite faint, it must be due to what we might describe as an accidental storm. Since all the others lie near the equator their courses are comparatively straight, probably within the limits of error for such small and faint objects.

There is only one canal south of the equator indicating distinct evidence of curvature, and that is the one shown in Figure 3. It is true that it crosses the equator as far as north latitude 3°, but it is

soon swept back again by the general circulation of the atmosphere towards the south, due to the condensing vapor at the south pole. The curvature is sharpest at the right hand end, showing that the wind had less velocity there, and that consequently it was blowing from the east and curving to the left, which is what it must do if due to an aerial current in the southern hemisphere (see Figure 1). The velocity diminished according to Table I, where the canal is designated as Eumenides and Gigas, from 19 to 12 miles. The latitude with regard to the heat equator is assumed to be $-5°$.

There is a nearly straight canal faintly shown to the south of Eumenides. It was seen but once by the writer, and is not given by either of the other observers. There is another straight canal however well shown near the bottom of Figure 5, and recorded by all of the observers. To the left of the little lake it is known as Protonilus, and to the right of it as Deuteronilus. It leads from the same polar marsh as Casius-Thoth and Nilosyrtis, is apparently straight, and seems therefore to present an exception to the rule which has hitherto applied to all the other canals. If we examine into the matter however we shall see that if it really were straight it would follow along the course of an ellipse whose center was at the center of the figure, and which was tangent to the canal where the latter crossed the central meridian. Since it does not follow this course, it clearly curves to the right, thus bearing the characteristic of all northern aerial currents.

Its radius of curvature is evidently large, however, and cannot be measured by the simple graphical process hitherto employed. It can nevertheless be computed from the latitude and longitude of points taken from the drawing, and also from the standard map. Its deviation from the great circle above described amounts to $37°$ in $90°$ of longitude. This gives it a radius of curvature of 2580 miles for latitude $45°$, and a corresponding velocity of the wind of 480 miles per hour. Measures from the map give a radius of 2980 miles for latitude $37°$ and a corresponding wind velocity of 460 miles per hour. These velocities are clearly impossible, so that the canal in spite of its correct curvature still apparently presents an exception to the rule. It also presents an exception to another rule, namely that all the large polar canals leave the polar marshes in an approximately southerly direction. It and the temporary canal between Aesacus and Anian have of late years always been the last of the polar canals to develop, Nilosyrtis being the first. It never even attained completion in 1914, only a small portion of Protonilus showing to the east of the little lake Ismenius, and a portion of Deuteronilus showing to the west of it. Since its duration is very

brief it is clearly of inferior importance in the seasonal economy of the planet. Its function seems to be to relieve the high pressure in Boreosyrtis by permitting it to discharge into Acidalium.

Regarding its great velocity we noted earlier a difference between the terrestrial and Martian meteorology, in that while our melting polar caps are taken care of by our oceans, and we have in consequence a marked low barometer in our polar regions, especially at the south, the Martian polar cap simply melts and evaporates, producing a high barometer with marked gradients at the summer pole. When the polar cap melts, the water collects at the three depressed regions on its border indicated by the tetrahedral theory of the planet's formation. Their positions are shown near the central meridians of Figures 2, 3, and 5. Over these marshy spots the storm clouds gather, and are swept away to the south as we have seen. But the atmospheric currents are leaving the pole for the equator in all directions, although it is only where the water collects that a permanent trace is left upon the surface of the planet. These invisible currents must therefore strike the westward moving stream of cloud over Protonilus-Deuteronilus at right angles to its course, sweeping it southerly, and straightening out the curve. This is evidently the reason that the measured radius of curvature of its track is so large. Thus we see that for currents so located, and having a westward course, the radius of curvature can really give us no clew whatever to the actual velocity of the wind.

These southerly winds it will be noted have a two-fold origin. They are due in part to the permanent low barometer at the equator, and in part to the melting of the northern polar cap. As the snow cap decreases in size with the advance of the season, if this latter cause is of importance, the force of these southerly currents should at first increase and then diminish in intensity, and we should therefore expect as the season advances to find the canal at first gradually shifting to the south, and then later shifting back again to the north.

In order to secure information on this point we may consult the maps of the planet published in the Reports of the Martian section of the British Astronomical Association. We shall find from them that in 1899 and 1901 when the polar cap was just beginning to decrease in size, the canal Deuteronilus discharged its contents directly into Niliacus, a large dark area located to the north west of Margaritifer, and forming the southern tip of Acidalium. In 1903 when the melting was well under way, and the wind in consequence blowing strongly from the north, the canal had shifted towards the south, and discharged mainly into Margaritifer, by means of a new branch canal called Tritonilus. In 1905 when the polar cap was still smaller, and the wind had decreased in intensity, Tritonilus was fainter, and the discharge

was about equally divided between Margaritifer and Niliacus. Finally in 1907, observed at a date still later in the Martian year, Tritonilus had disappeared altogether, and Deuteronilus discharged as in 1899 and 1901 directly into Niliacus. From this we conclude that, while the equatorial low barometer may be of paramount importance in deflecting this canal to the south, the rush of vapor from the melting snow cap, when the latter is diminishing in size, also produces an effect by no means to be neglected.

During our December observation of this region at the last opposition, in 1915, ⊙ 31°.9, M. D. April 11, the canal was seen for the first time that year. It was then pointed towards Niliacus, but did not reach beyond longitude 5°. Margaritifer had not yet developed. In January 1916, ⊙ 47°.9, M. D. April 45, Margaritifer had developed in full, and also the canals Oxus and Indus. Deuteronilus had advanced to longitude 15°, but did not yet carry enough moisture to close the connection either with Niliacus, or with Margaritifer, through Oxus. In the following March, ⊙63°.2, M. D. May 23, as shown in Report No. 17, Figure 2, the connections with both Margaritifer and Niliacus were established. By April, ⊙ 77°.1, M. D. May 55, the connection with Niliacus was severed, and the canal was discharging only into Margaritifer and Sabaeus. Thus again we find that as the snow cap melted, the canal was obliged to discharge its contents farther to the south. At the present opposition it is thought we may see the continuation of the process, and the return of the canal to the north, thus again directing its discharge into Niliacus. It is believed we are thus at last beginning to find a reason for the mysterious changes that are sometimes found to occur in the location of the canals.

At the last opposition the snow cap decreased very rapidly in size during the Martian month of May, being reduced from its original diameter of 70° to but 16° at the end of that month; yet the canal area as a whole showed no diminution at that date, in fact on the contrary it had rather increased in size. If the canals are marshes or marshy ground, this observation would indicate their efficiency to serve as reservoirs of moisture during the three succeeding Martian months, until the moisture is again released by the melting of the southern polar cap. From the end of the Martian May until the autumnal equinox upon the planet, when the snow again begins to melt, is rather more than six of our months.

Historical Summary.

A brief reference may now be made to some of the earlier explanations of the Martian canals, omitting the more absurd and improbable ones, such as that they were ploughed up by glancing asteroids, or that

they were isthmuses between light colored seas. The first canal and lake clearly seen and accurately plotted were Nectaris and Solis Lacus, which appear on Beer and Maedler's map of the planet in 1840 (Planète Mars, p. 107. Flammarion). Up to 1877 about a dozen astronomers, including De la Rue, Secchi, Lockyer, Lassell, Kaiser, Dawes, and Green had each seen a few canals. Proctor had indicated half a dozen on his map in 1867, and Flammarion a few more on his in 1876. In 1878 Schiaparelli first attracted general attention to the subject however by publishing a map containing some forty canals and several lakes. Since then they have been widely discussed, but only very few explanations of them have ever been generally accepted.

The first to meet general favor was that they were really water channels. This was discredited somewhat later however, when it was shown that some of them crossed the so-called seas (Astron. Astro-Physics 1892, **11**, 668). The next suggestion was that the surface of Mars consisted in large part of desert areas, and that only the comparatively small dark spots or seas were due to vegetation (Science 1888, **12**, 82). This view still holds, and is in fact generally maintained at the present day. Then came the suggestion that the canals were bands of vegetation watered by invisible central ditches. This view was enthusiastically embraced and adopted by the late Dr. Lowell, and in its original form was first published by him in 1895 in his book entitled Mars (p. 165). Through his skill as a popular lecturer and writer, and also owing doubtless in part to his addition to it of the suggestion that the water was pumped through the ditches artificially, thus making the suggestion much more picturesque, this view has been very widely accepted by the general public.

It has indeed heretofore always been found very difficult to account for the canals without having recourse to some sort of intelligent action, and various suggestions based on this idea have been offered to explain them, none of which however, as our information increased, have proved entirely satisfactory (see Report on Mars **6**, 12, and **7**, 9). Owing to the increased accuracy of recent observations we are now beginning to learn the real shape of the canals, and that once determined, it was but a step to apply to them Ferrel's theory of the winds. The writer is therefore now prepared to offer this explanation of all the broader and more important canals to the astronomical world, and particularly to the meteorologists, for their criticisms and suggestions, in the hope that they may find in it a more satisfactory explanation of this much discussed phenomenon than in those theories that have preceded it.

With regard to the narrower or secondary type of canals, a few of which are shown in Figure 5, it should be noted that they only appear late in the season, but are then very numerous. Over 500 have been

located and named at the Lowell Observatory since its foundation in 1894. The main question to be settled regarding them is as to their origin. (*a*) Are they artificial, as has been claimed, or (*b*) do they simply indicate the paths of local more or less accidental showers, or finally (*c*) is their uniformity and apparent straightness merely an illusion, like that of the lunar pseudo-canals, visible with an ordinary opera glass, which resemble them, and are described in detail in Report No. 6?

Without attempting to decide between these explanations, the writer is inclined to believe that there are certain positions where these canals readily form, and certain others where they are seldom seen, and that there is a great deal still to be learned with regard to them.

Especial attention should be paid to their curvature, hourly changes, duration, stability of position, longitudinal development, and the formation and disappearance of any lakes in connection with them. Since on account of the season on Mars this will be an ususually favorable opposition for their study, every one able to distinguish them should do all in his power to settle the question of their origin. There is no question, however, but that they are very difficult telescopic objects, and it is probable that there are but three observatories in the world, namely those which have resolved the Aristillus test, that possess the necessary combination of climate and equipment to see them distinctly. The Lowell Observatory is already definitely committed to the explanation that they are artificial, and in any case the seeing there in the early spring is not as good as it is later, with the arrival of warm weather. It is uncertain whether the Jarry-Desloges Observatory at Setif will be opened this year on account of the war, but it is known that if it is, it will not have the observers and equipment that it employed in former years. Our station, although well enough equipped for the study of the broader canals, will suffer in the study of the finer ones from the smallness of our aperture, Every effort will nevertheless be made to solve the problem this year, if it is possible to do so.

Summary of the Present Theory.

We may now briefly summarize what may be termed the "Theory of Aerial Deposition," as applied to the broader Martian canals. As distinguished from the "Theory of Irrigating Ditches," it starts out with the statement that the function of the canals is not to conduct the water from the northern polar cap to the southern hemisphere, where most of the vegetation is to be found, but rather to retard its transportation. Without these natural marshes or reservoirs, it is believed that the water evaporated from the summer pole would find its way

too rapidly, through the natural general atmospheric circulation of the planet, to the southern polar regions, where, wrapped at this season in the long winter night and subjected to the cold of space, it would quickly be withdrawn from further use in the support of vegetal and perhaps animal life. The function of the so-called canals or marshes in the economy of the planet is in short to furnish a substitute for our oceans, and to furnish by evaporation during the Martian summer a steady and continuous supply of water after that derived from the northern snows has appreciably diminished.

The water from the melting polar cap according to this theory is deposited in the three main depressions on its border, and is then evaporated and carried by the aerial circulation of the planet along the curved lines, which in accordance with Ferrel's theory of the circulation of the winds it must necessarily follow. The storm clouds, which in that rare atmosphere should condense at night, would in this manner carry the water and deposit it in the elongated marshes which we see, and call canals.

From the shape and radius of curvature of these canals we can determine the direction and velocity of the wind. From the maximum velocity of the wind we find that the minimum pressure of the atmosphere cannot be less than 7.5 inches of mercury. From various other considerations it appears that this cannot be far from its true value. The corresponding temperature of boiling water on Mars would therefore be about 150° F. (66° C).

Mandeville, Jamaica, B. W. I.
November 28, 1917.

THE LEONIDS IN 1917.

CHARLES P. OLIVIER.

The Leonids form the most important of the meteor systems, and they should be carefully observed every year in order to obtain all the information possible as to their distribution around their orbit. Therefore though in 1917 they were almost as far from their maximum as possible, being only two years past their half-period point, it was decided to observe them.

Clouds prevented work on November 14, which is usually the date on which they are most frequent, and November 15 was cloudy also,

but very clear skies on the next two nights gave excellent opportunities for observation. On November 16 work was started at $13^h\ 42^m$ and carried to $16^h\ 30^m$, a total of 168^m. Of this time about 40^m was required for recording, etc. In all 36 meteors were seen, of which 16 were Leonids. These latter presented their usual characteristics, but not less than four colors were represented, and two of their trains lasted 4^s. The radiant point was a small area $2°x1°$, the center of which was at $\alpha = 152°.0$, $\delta = +23°.3$, and is considered to be derived with considerable accuracy. Among others seen the same night, one blue meteor, not a Leonid, appeared low in the south as of the third magnitude and, passing through an arc of $60°$ in 4^s, disappeared considerably higher toward the east as of the second magnitude.

On November 17, observations began at $13^h\ 10^m$ and continued until $14^h\ 45^m$, a total of 140^m, making allowance for a 15^m interval, but none for the 15^m used in recording. In all 19 meteors were seen, 4 being Leonids. Unfortunately one was low in the haze and could not be mapped, while the paths of the other three were too nearly parallel to give an accurate radiant. However, these three meteors would all pass through the radiant secured the previous night, and there probably was not enough shift in the one day to be certainly detected, even had more meteors been accurately plotted.

Considering the fact that we were passing through that part of the stream so far from its greatest density, and that observations began two days after the usual date of maximum, rather a larger number of meteors were seen than was expected. It is also hoped that other members of the American Meteor Society will send in reports covering November 14 and 15, but these will not be received until the end of the month.

The rather good results obtained this year should encourage observers to pay attention to the Leonids every November, since it seems a radiant can certainly be obtained any year. This opportunity is also taken to remind all persons interested in meteoric astronomy that, whether they are at present members of the American Meteor Society or not, they may obtain maps for plotting meteors, standard blanks for recording, and complete instructions for their use, at any time by merely writing to the author. More observers are urgently needed, and we will be very glad to give prompt attention to all communications on the subject.

Leander McCormick Observatory,
University of Virginia.
1917, November 23.

ASTRONOMICAL PHENOMENA IN 1918.

ECLIPSES.

In the year 1917 there were seven eclipses, four of the sun and three of the moon, which is the maximum number that can occur in any year. In 1918 there will be but one more than the minimum number that must occur in any year. The minimum number is two, both of the sun. In 1918 there will be two of the sun and one of the moon. The one of greatest interest is the total eclipse of the sun on June 8. Frequent notes and papers concerning this eclipse have appeared in POPULAR ASTRONOMY and other astronomical journals during the past year, and others will appear until the time of the eclipse. Doubtless many of the observatories of the United States will send expeditions to points along the path of totality for the purpose of observing the phenomenon so rare for any given locality. Some few observatories are so fortunate as to be situated exactly in the path, which extends across the United States from the northwest to the southeast. Although the path of totality is narrow, varying from 60 to 75 miles in the United States, the eclipse will be visible as a partial one at all points in the United States, the percentage of totality depending upon the distance of the place from the center of the path. The following cities are situated in the path and will be in the shadow at the times and for the periods indicated.

City	Time of Total Eclipse.			Approximate Duration of Totality	
	h	m		m	s
South Bend, Wash.	2	55	P. S. T.	2	01
Heppner, Ore.	3	02	P. S. T.	1	56
Baker City, Ore.	3	05	P. S. T.		53
Pocatello, Idaho	4	13	M. S. T.		44
Denver, Colo.	4	24	M. S. T.		30
Dodge City, Kan.	4	29	M. S. T.	1	05
Guthrie, Okla.	5	33	C. S. T.	0	45
Murfreesboro, Ark.	5	34	C. S. T.		45
Jackson, Miss.	5	38	C. S. T.		45
Orlando, Fla.	5	45	C. S. T.	0	45

Following is a list, taken from the *Supplement to the American Ephemeris* for 1918, of cities not in the path of totality, showing the times of beginning, middle and end of the eclipse, and the percentage of the sun's disc which will be obscured. The times have been changed from Greenwich Mean Time to the Standard Time of the belt in which the city is located.

Place	Beginning			Middle		End		Magnitude
	h	m		h	m	h	m	
Albany, N. Y.	5	30	E. S. T.	6	23	7	14	0.64
Allegheny, Pa.	4	30	C. S. T.	5	27	6	20	0.74
Amherst, Mass.	5	30	E. S. T.	6	24	7	13	0.64
Ann Arbor, Mich.	4	26	C. S. T.	5	25	6	20	0.74
Appleton, Wis.	4	21	C. S. T.	5	22	6	18	0.75
Atlanta, Ga.	4	36	C. S. T.	5	36	6	32	0.92
Augusta, Me.	5	29	E. S. T.	6	20	7	08	0.58
Austin, Tex.	4	34	C. S. T.	5	40	6	39	0.87
Baton Rouge, La.	4	37	C. S. T.	5	40	6	38	0.95
Berkeley, Cal.	1	49	P. S. T.	3	10	4	22	0.79
Bismarck, N. D.	4	07	C. S. T.	5	14	6	16	0.81
Boise City, Idaho	2	51	M. S. T.	4	08	5	18	0.99
Buffalo, N. Y.	5	28	E. S. T.	6	24	7	16	0.69

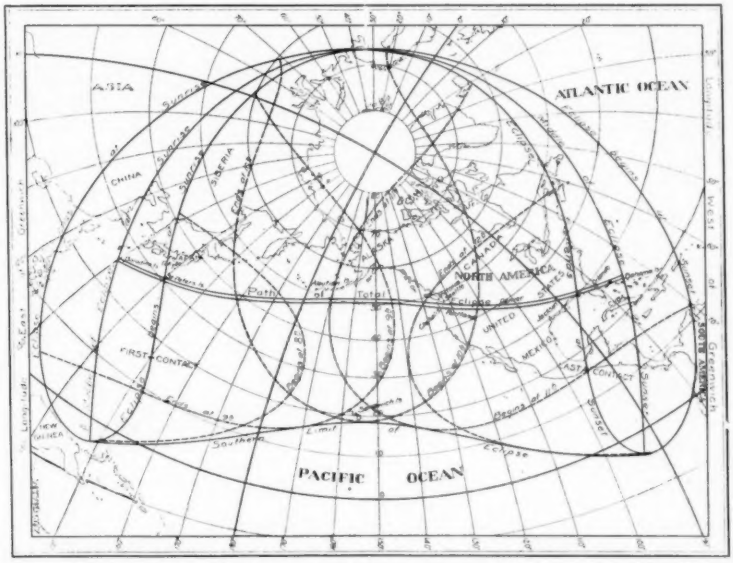
Place	Beginning			Middle		End		Magnitude
	h	m		h	m	h	m	
Cambridge, Mass.	5	31	E. S. T.	6	23	7	12	0.63
Carson City, Nev.	2	52	M. S. T.	4	11	5	22	0.85
Charleston, W. Va.	4	32	C. S. T.	5	30	6	24	0.80
Charlottesville, Va.	5	33	E. S. T.	6	30	7	23	0.77
Cheyenne, Wyo.	3	10	M. S. T.	4	21	5	25	0.97
Cincinnati, O.	4	29	C. S. T.	5	30	6	24	0.81
Cleveland, O.	4	28	C. S. T.	5	26	6	20	0.74
Columbia, Mo.	4	25	C. S. T.	5	29	6	28	0.89
Columbia, S. C.	5	37	E. S. T.	6	36	7	30	0.88
Columbus, O.	4	29	C. S. T.	5	28	6	23	0.78
Des Moines, Ia.	4	20	C. S. T.	5	25	6	24	0.85
Dover, Del.	5	33	E. S. T.	6	28	7	20	0.72
Evanston, Ill.	4	24	C. S. T.	5	25	6	22	0.78
Flagstaff, Ariz.	3	11	M. S. T.	4	26	5	32	0.83
Geneva, N. Y.	5	28	E. S. T.	6	24	7	15	0.67
Greencastle, Ind.	4	28	C. S. T.	5	29	6	25	0.82
Hanover. N. H.	5	29	E. S. T.	6	22	7	11	0.61
Harrisburg, Pa.	5	31	E. S. T.	6	27	7	19	0.72
Helena, Mont.	2	54	M. S. T.	4	08	5	15	0.92
Honolulu, Hawaii	1	01	P. S. T.	1	45	2	30	0.09
Iowa City, Iowa	4	22	C. S. T.	5	25	6	23	0.83
Ithaca, N. Y.	5	29	E. S. T.	6	24	7	16	0.67
Juneau, Alaska	1	15	P. S. T.	2	29	3	40	0.77
Kansas City, Mo.	4	23	C. S. T.	5	28	6	28	0.91
Little Rock, Ark.	4	30	C. S. T.	5	35	6	33	0 99
Louisville, Ky.	4	30	C. S. T.	5	31	6	26	0.84
Madison, Wis.	4	22	C. S. T.	5	24	6	20	0.78
Minneapolis, Minn.	4	16	C. S. T.	5	20	6	18	0.78
Montgomery, Ala.	4	37	C. S. T.	5	38	6	34	0.97
Mt. Hamilton, Cal.	1	51	P. S. T.	3	12	4	23	0.78
Mt. Wilson, Cal.	2	03	P. S. T.	3	21	4	29	0.74
Nashville, Tenn.	4	32	C. S. T.	5	34	6	30	0.90
New Haven, Conn.	5	31	E. S. T.	6	25	7	15	0.66
New Orleans, La.	4	38	C. S. T.	5	41	6	38	0.95
New York, N Y.	5	32	E. S. T.	6	26	7	16	0.68
Nome, Alaska	0	49	P. S. T.	1	55	3	2	0.63
Oklahoma City, Okla.	4	26	C. S. T.	5	33	6	33	0.99
Omaha, Nebr.	4	19	C. S. T.	5	25	6	25	0.88
Orono, Me.	5	29	E. S. T.	6	19	7	07	0.56
Oxford, Miss.	4	33	C. S. T.	5	36	6	33	0.96
Panama, Panama	5	08	C. S. T.	—		—		—
Philadelphia, Pa.	4	32	E. S. T.	5	27	6	18	0.71
Phoenix, Ariz.	3	13	M. S. T.	4	28	5	33	0.79
Pierre, S. Dak.	4	11	C. S. T.	5	18	6	20	0.86
Portland, Ore.	1	38	P. S. T.	2	58	4	11	0.99
Poughkeepsie, N. Y.	5	31	E. S. T.	6	25	7	15	0.66
Raleigh, N. C.	5	36	E. S. T.	6	33	7	26	0.82
Richmond, Va.	5	34	E. S. T.	6	31	7	23	0.77
Sacramento, Cal.	1	50	P. S. T.	3	10	4	22	0.82
Salt Lake City, Utah	3	01	M. S. T.	4	17	5	24	0.97
San Juan, P. R.	5	52	E. S. T.	—		—		—
Santa Fe, N. Mex.	4	17	C. S. T.	5	29	6	33	0.91
Seattle, Wash.	1	37	P. S. T.	2	56	4	08	0.98
Springfield, Ill.	4	26	C. S. T.	5	28	6	25	0.85
St. Louis, Mo.	4	27	C. S. T.	5	30	6	27	0.88
Syracuse, N. Y.	5	28	E. S. T.	6	23	7	14	0.66
Tallahassee, Fla.	4	40	C. S. T.	5	40	6	35	0.99
Topeka, Kan.	4	22	C. S. T.	5	28	6	28	0.93
Tuscaloosa, Ala.	4	35	C. S. T.	5	37	6	34	0.97
Ukiah, Cal.	1	46	P. S. T.	3	07	4	20	0.82
Urbana, Ill.	4	26	C. S. T.	5	28	6	25	0.83
Washington, D. C.	5	33	E. S. T.	6	29	7	21	0.74
Williams Bay, Wis.	4	23	C. S. T.	5	24	6	21	0.78

The circumstances of the eclipse are as follows:

		Gr. M. T.		Longitude from Greenwich		Latitude	
		h	m	°	′	°	′
Eclipse begins	June 8	7	29.0	−150	20	+16	22
Central eclipse begins		8	32.2	−129	58	+25	41
Central eclipse at local apparent noon		10	07.4	+152	10	+50	51
Central eclipse ends		11	42.9	+ 74	31	+25	23
Eclipse ends		12	46.2	+ 94	53	+16	03

The accompanying chart shows the parts of the earth's surface from which the eclipse will be visible.

TOTAL ECLIPSE OF JUNE 8, 1918.



Note:—The hours of beginning and ending are expressed in Greenwich Mean Time

The second eclipse of the year is a partial eclipse of the moon on June 23-24. Only about one-seventh of the moon's surface will be eclipsed. It will be visible generally in North and South America and in the Pacific.

The circumstances of the eclipse are as follows:

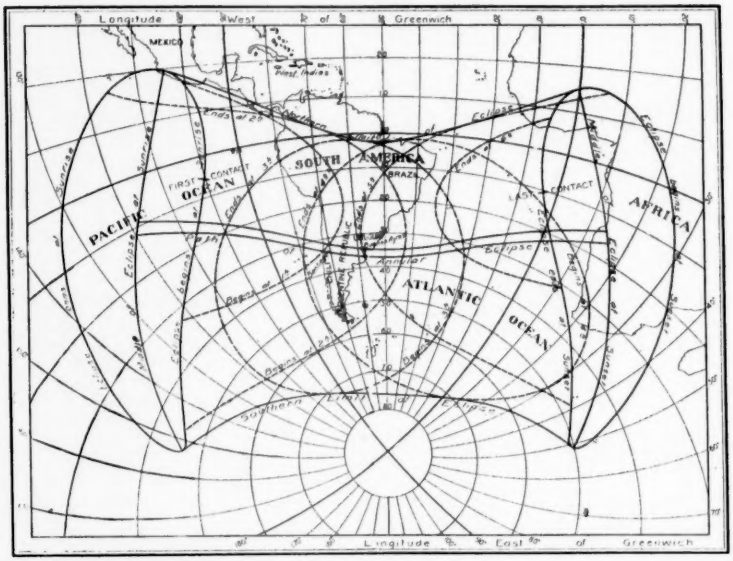
	d	h	m	
Moon enters penumbra	June 23	20	8.7	G. M. T.
Moon enters umbra		21	46.4	
Middle of the eclipse		22	28.0	
Moon leaves umbra	23	23	09.8	
Moon leaves penumbra	24	00	47.1	

The third eclipse is an annular eclipse of the sun on December 3. This eclipse, as shown by the chart, will be visible in the Pacific, in South America, in the Atlantic, and in the western part of Africa. It will not be visible in North America.

The circumstances of the eclipse are as follows:

	G. M. T.			Long. from Greenwich		Latitude	
	d	h	m	°	′	°	′
Eclipse begins	Dec. 3	0	21.3	+100	17	− 5	52
Central eclipse begins		1	28.8	+119	07	−10	36
Central eclipse at local apparent noon		3	23.0	+ 53	19	−36	05
Central eclipse ends		5	14.9	− 14	59	−15	04
Eclipse ends		6	22.3	+ 3	53	−10	21

ANNULAR ECLIPSE OF DECEMBER 3, 1918.



Note:—The hours of beginning and ending are expressed in Greenwich Mean Time.

The charts as well as the data concerning the eclipses are taken from the *American Ephemeris* for 1918.

THE PLANETS.

As in former years charts have been prepared at the Goodsell Observatory showing the wanderings of the planets among the stars during 1918. These charts are given here (Figures 1, 2), and a little study will enable the reader to get from them the data they contain. As the paths of the planets lie within thirty degrees of the equator, only that portion of the sky is plotted. The path of the sun is a smooth curve called the ecliptic which lies north of the equator from 0^h to 12^h and south of the equator from 12^h to 24^h. The position of the sun in its orbit may readily be obtained for any date by noting that the sun moves eastward at the average rate of two hours each month beginning at 0^h at the time of the vernal equinox, about March 22. The positions of the planets are indicated at the beginning of each month, or less frequently in case the motion is small. By determining the position of the sun at any date

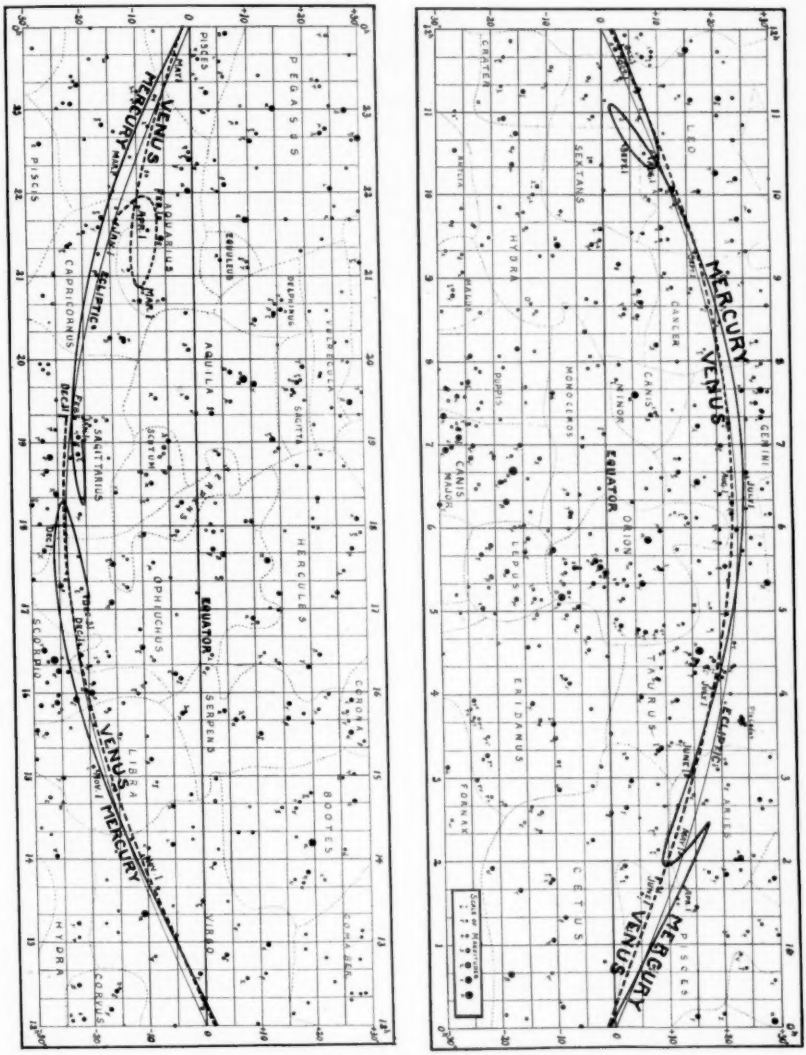


FIG. 1. Apparent paths of the planets Mercury and Venus among the stars during the year 1918.

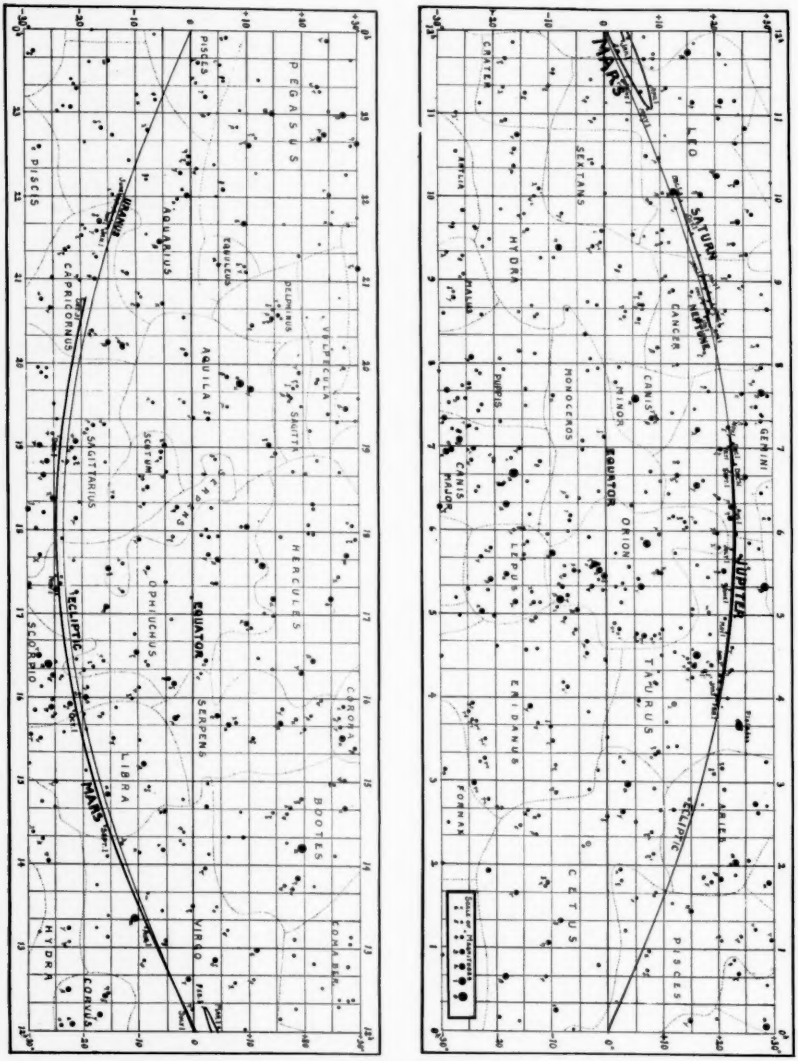


FIG. 2. Apparent paths of the planets Mars, Jupiter, Saturn, Uranus and Neptune among the stars during the year 1918.

and by noting the position of a given planet at the same date, one can ascertain at once whether the planet in question is visible or not, it being invisible in case it is too near the sun to appear in the sky before sunrise or after sunset. For example, Venus is seen to be at about 1^h 45^m on June 1, while the sun at this date will be near 4^h 45^m. Venus therefore at this date will be approximately 3^h west of the sun and will consequently rise about 3^h earlier and be a bright morning star at this date. These charts may also be used for studying the constellations along the equator and for identifying the brighter stars. A star which is 12^h from the sun at the given date will be on the meridian at midnight on that date.

Mercury begins the year with a westward motion but turns and moves eastward from the middle of January until the middle of April, when it again moves westward for a few weeks. After this it moves eastward again until the middle of August, then describes a loop in Sextans and Leo, then moves eastward again until December 10, then westward until near the end of the month, when it again starts eastward just at the close of the year. Mercury will be too near the sun to be visible at the beginning of the year, and also near the dates: March 12, April 26, June 26, September 1, October 15, December 18. It will be visible in the morning just before sunrise on and near the following dates: January 25, May 24, September 17; and in the western sky just after sunset on and near the following dates: April 7, August 5, November 29. Mercury will end the year about two hours west of the point at which it started.

Venus will be seen from the chart to begin its course for the year in the constellation Capricornus. It will pass into Aquarius and by moving backwards (westward) in the sky from the middle of January until March 1, and then eastward again, it will describe a loop in this constellation. From this on it continues its course eastward throughout the year, keeping rather close to the ecliptic and ending

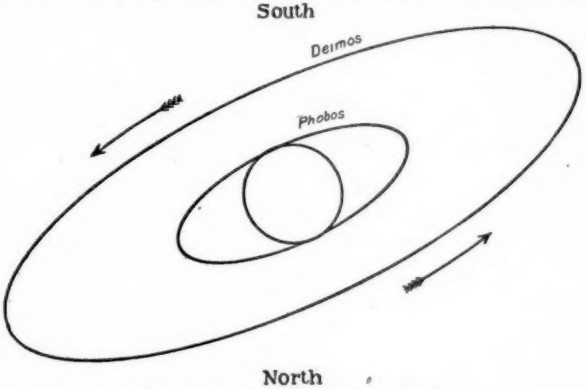
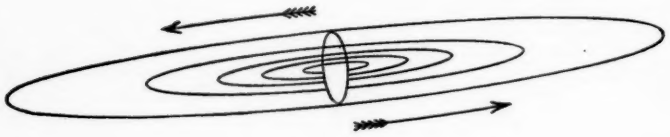


FIG. 3. SATELLITES OF MARS, 1918.
Apparent orbits of the Satellites of Mars at Date of Opposition, March 14, 1918, as seen in an inverting telescope.

the year in Sagittarius. It will be at a period of greatest brilliancy in the western sky on January 4, and again in the eastern sky on March 16. Venus will pass the sun and therefore be invisible on and near the following dates: February 9, November 23. It will be a brilliant evening star during January and again toward the end of the year. It will be a brilliant morning star during April and May.

Mars will move eastward during January, westward during February and March and then eastward during the rest of the year. As the orbit of Mars lies outside that of the earth, the planet does not complete the circuit of the sky in a year. Its path for this year begins in Virgo and ends in Capricornus. Mars will be in opposition on March 14. It will then be in best position for observation during the year. At this time Mars will be about 60,000,000 miles from the earth. Figure 3 shows the apparent paths of the satellites at this date.

South

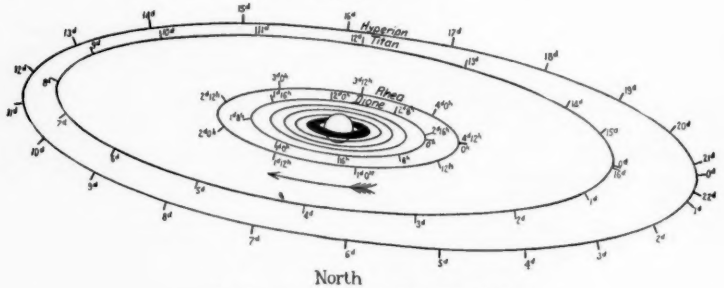


North

FIG. 4. SATELLITES OF JUPITER, 1918.
Apparent Orbits of the Satellites of Jupiter at date of Opposition, January 1, 1919, as seen in an inverting telescope.

Jupiter describes a short path from Taurus into Gemini. It will be moving westward both at the beginning and at the end of the year. Its course begins a little to the southeast of the Pleiades and ends a little to the southwest of Pollux. Jupiter will not quite reach its point of opposition during 1918. It will, however, reach it on January 1, 1919. Jupiter will be well situated for observation both at the beginning and at the end of the year. It will not be visible during the summer months, as it will be in conjunction with the sun on June 15. Figure 4 shows the apparent orbits of the satellites at the opposition on January 1, 1919.

South



North

FIG. 5. SATELLITES OF SATURN, 1918.
Apparent Orbits of the Seven Inner Satellites of Saturn at Date of Opposition, January 31, 1918, as seen in an inverting telescope.

Saturn moves westward in Cancer during January, February and March. It then moves eastward into Leo and ends the year very near to the bright star

Regulus. Saturn will be in opposition on January 31. Figure 5 shows the apparent paths of the satellites of Saturn at the date of opposition.

Uranus moves back and forth near the boundary line between Capricornus and Aquarius, ending the year about one-third of an hour to the east of its starting point. Uranus will be in conjunction with the sun on February 12 and will therefore be invisible during the beginning of the year. It will be in opposition on August 19, and therefore be favorably situated during the summer months.

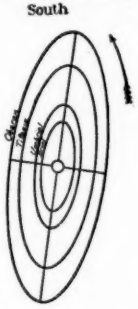


FIG. 6. SATELLITES OF URANUS, 1918. Apparent Orbits of the Satellites of Uranus at date of Opposition, August 19, 1918, as seen in an inverting telescope.

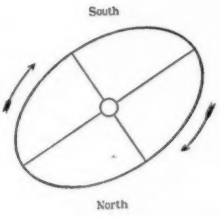


FIG. 7. SATELLITE OF NEPTUNE, 1918. Apparent Orbit of the Satellite of Neptune at date of Opposition, January 25, 1918, as seen in an inverting telescope.

Neptune shifts its position a short distance to the east in Cancer. It will be in opposition on January 25, and in conjunction with the sun on July 30. It will therefore be most favorably situated for observation near the beginning and the end of the year.

Figures 3, 4, 5, 6, 7 were copied from the *American Ephemeris* for 1918.

COMETS.

This year six periodic comets are due to return to perihelion, and four of them under favorable conditions for their rediscovery, at some time during the year. Wolf's comet *b* 1916 will still be visible in large telescopes, although far out from the sun.

1. Comet Brooks 1889 V, which has a period of revolution round the sun of 7.1 years, is due at perihelion about February 13, according to the elements published in 1910 in *Astronomische Nachrichten* No. 4437. It will then be on the opposite side of the sun from the earth and so is not likely to be found. It was seen only once at the 1910-11 return, when it was close to the predicted position but exceedingly faint. For the next few returns its position will be less and less favorable for observation.

2. Faye's comet, with a period of 7.39 years, should be at perihelion about March 15. At that time it will be far from the earth, almost on the opposite side of the sun, and so it is not likely to be picked up during thisyear.

3. Encke's comet, which makes its circuit round the sun every 3.3 years, is due at perihelion about March 24. It should be within range of large telescopes in the

early evening but is moving in toward conjunction with the sun. At the time of perihelion it will be very unfavorably situated for observation. In May, June and July, southern observers will have a rather good chance to observe this comet.

4. Comet Tempel I, returning every 6.5 years, is due at perihelion May 18 and will then be nearly at opposition, so that its position will be very favorable for observation during the spring and summer months.

5. Borrelly's comet 1905 II, period 6.9 years, will be near perihelion November 18. The position should be very favorable to its rediscovery. It was quite conspicuous in a small telescope at the return in 1911.

6. Wolf's periodic comet should be at perihelion in the latter part of December. It will then be about 90° east from the sun. It was seen with difficulty in 1911 when only 30° out from the sun. This year the position at and before perihelion is a good deal more favorable.

METEORS.

On any clear night one needs to watch the sky for only a short time in order to see the phenomenon of a "falling star". The earth is constantly being bombarded by small particles which are attracted into the earth's atmosphere and there consumed. It is very rare that this phenomenon is accompanied by such brilliancy as to be visible in daytime, and many of the particles strike the atmosphere and are dissipated without being visible even at night. At certain seasons the earth passes through regions in which the particles seem more numerous than in other regions, and hence meteoric showers are predicted for these dates. At the times of these showers, a number are seen to emanate from the same region in the sky. These points are called radiants, and do not change essentially from year to year. Below is given a list of dates and radiants as given by W. F. Denning in *The Companion to The Observatory for 1917.*

Date	Radiant		Character
	α	δ	
	°	°	
Jan. 2-3	230	+52	Swift; long paths.
Apr. 20-21	271	+33	Swift.
May 4	334	−2	Swift; streaks.
Aug. 10-11	44	+57	Swift; streaks.
Oct. 19-20	92	+15	Swift; streaks.
Nov. 14-15	150	+22	Swift; streaks.
Nov. 22	63	+22	
Dec. 11-12	111	+33	Swift; short.

VARIABLE STARS.

The computed times of maxima of a list of about eighty short period variables and of minima of about one hundred others will be published again, one month in advance throughout the year. These computations are made at the Goodsell Observatory from elements which are kept up-to-date as far as it is possible to find published results concerning any of the stars. It would be an interesting exercise for those who have the use of small telescopes principally for pleasure to verify the times as given.

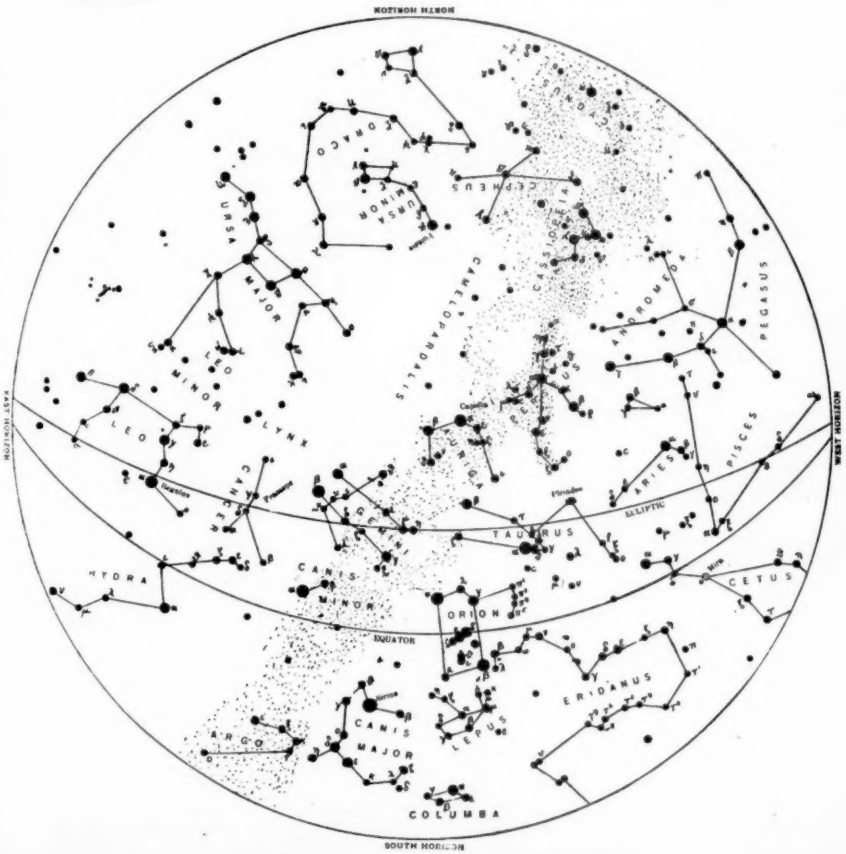
The actual observations of variables of long period as furnished by the members of the American Association of Variable Star Observers will also be published as before.

OCCULTATIONS.

For the convenience of those who may not have access to the *American Ephemeris* we shall, as formerly, select from this volume the list of stars to be occulted by the moon in a given month and publish them one month in advance. Only those are taken which are visible at Washington, as the list containing all which are occulted would be entirely too long. None of the brightest stars will be occulted this year, although all that are given could be observed with the aid of a small telescope or even with opera glasses.

PLANET NOTES FOR FEBRUARY, 1918.

The sun will continue to move in a northeasterly direction during the month. It will move from Capricornus into Aquarius through a region in which there are no bright stars.



THE CONSTELLATIONS AT 9:00 P. M. FEBRUARY 1.

The phases of the moon for this month are as follows:

Last Quarter	Feb.	4	at 2 A.M.	C.S.T.
New Moon		11	" 4 A.M.	"
First Quarter		17	" 7 P.M.	"
Full Moon		25	" 4 P.M.	"

Mercury may possibly be visible just before sunrise at the beginning of the month. It will however be moving rapidly eastward toward the sun and soon will be too near to it to be visible.

Venus will pass between the earth and the sun on February 9. It will therefore be too near the sun during the month to be visible.

Mars will be rising earlier each night during the month. By the end of the month it will be on the meridian soon after midnight. It will also be approaching the earth, being in the neighborhood of 75,000,000 miles away.

Jupiter will be visible west of the meridian in the early evening during the month. About the middle of the month it will be on a straight line between the Pleiades and Aldebaran.

Saturn will rise a little before sunset and be in good position in the eastern sky in the evening. It will be moving westward during the month. It will be in the constellation Cancer, and not near any bright star.

Uranus will be in conjunction with the sun on February 12 and will therefore be invisible during the month.

Neptune will cross the meridian about eleven in the evening during the month and will therefore be in the eastern sky in the evening.

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[*From the American Ephemeris.*]

CENTRAL STANDARD TIME.

1918	h	m			1918	h	m		
Feb. 1	5	28	I	Sh. I.	Feb. 14	11	30	III	Sh. E.
	6	25	I	Tr. E.	15	8	1	I	Tr. I.
	7	38	I	Sh. E.		9	18	I	Sh. I.
	7	48	II	Tr. I.		10	11	I	Tr. E.
	10	19	II	Tr. E.		11	28	I	Sh. E.
	10	20	II	Sh. I.	16	5	18	I	Oc. D.
	12	50	II	Sh. E.		8	50	I	Ec. R.
3	7	10	II	Ec. R.	17	5	57	I	Sh. E.
	10	0	III	Oc. D.		7	13	II	Oc. D.
	12	10	III	Oc. R.		9	46	II	Oc. D.
6	11	39	I	Tr. I.		9	51	II	Ec. D.
7	5	14	III	Sh. I.	19	7	27	II	Sh. E.
	7	28	III	Sh. E.	21	7	55	III	Tr. I.
	8	55	I	Oc. D.		10	8	III	Tr. E.
	12	25	I	Ec. R.	22	9	55	I	Tr. I.
8	6	7	I	Tr. I.		11	13	I	Sh. I.
	7	23	I	Sh. I.	23	7	14	I	Oc. D.
	8	17	I	Tr. E.		10	45	I	Ec. R.
	9	33	I	Sh. E.	24	5	42	I	Sh. I.
	10	21	II	Tr. I.		6	34	I	Tr. E.
9	6	54	I	Ec. R.		7	52	I	Sh. E.
10	7	12	II	Oc. R.		9	49	II	Oc. D.
	7	15	II	Ec. D.	25	5	28	III	Ec. R.
	9	47	II	Ec. R.		7	26	II	Tr. E.
14	6	9	III	Tr. E.	26	6	34	II	Sh. I.
	9	15	III	Sh. I.		10	5	II	Sh. E.
	10	49	I	Oc. D.					

Note:—I., denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

Satellites of Jupiter, 1918.

GREENWICH MEAN TIME.

FEBRUARY

Phases of the Eclipses of the Satellites for an Inverting Telescope.

I. r

III. d r

II. d r

IV. No Eclipse

Configurations at 14h 45m for an Inverting Telescope.

Day	West	East
1	○ 2· 3· 1·	○ 4·
2	·3 ·2 ○ ·1 4·	
3	1· ·○ 3 ·24.	
4	4· ○ 1·2· ·3	
5	4· 2· ·1 ○ 3·	
6	4· ·2 ○ 1· 3·	
7	4· 3· .○ 1 ·2	
8	.4 3· 1.○ 2·	
9	·4 ·3 2· ○ ·1	
10	4 1· ·3 ○	·2●
11	·4 ○ ·1 2· ·3	
12	2· ·1 ○ ·4 ·3	
13	2· ○ .1 3· ·4	
14	3· ·1 ○ ·2 ·4	
15	○ 1· 3· ○ 2· ·4	
16	·3 2· ○ ·4	·1●
17	1· ·3 ○ 4·	·2●
18	○ .1 ·32· 4·	
19	·12· ○ 4· ·3	
20	·2 ○ 4·1· ·3	
21	○ 3· 4· .1 ○ 2·	
22	4· 3· ○ 1· 2·	
23	4· ·3 2· ○	·1●
24	4· ·3 1· ·○ 2	
25	·4 ○ ·1 ·3 2·	
26	·4 1· 2· ○ ·3	
27	·4 ·2 ○ ·1 3·	
28	·4·1 ○ 3· ·2	

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1918	Star's Name	Magnitude	IMMERSION. Washington M.T. h	m	Angle f'm N. °	EMERSION. Washington M.T. h	m	Angle f'm N. °	Duration h	m
Feb. 3	43 B Librae	5.7	18	18	95	19	47	299	1	29
5	126 B Scorpii	6.1	14	55	69	15	50	317	0	56
17	133 B Tauri	5.9	9	31	133	10	20	222	0	48
17	32 Tauri	5.8	12	32	81	13	24	278	0	52
18	300 B Tauri	6.2	7	55	98	9	18	264	1	23
25	237 B Leonis	6.3	17	41	137	18	38	273	0	57
26	*e* Leonis	5.1	13	30	146	14	52	286	1	22
28	370 B Virginis	6.0	10	11	185	10	40	234	0	29

COMET AND ASTEROID NOTES.

Asteroids Discovered by Joel H. Metcalf.—The following is the list of asteroids discovered either at Taunton or Winchester which were sufficiently observed to give good orbits. They were all photographed by the method described in the Astrophysical Journal Volume XXIII No. 4, May 1906. Many other asteroids, perhaps three times as many, were picked up that promised to be new, but faintness, bad weather or something else prevented their being followed the month or six weeks required to assure a good elliptic orbit.

Searching for minor planets resembles the piscatorial art, and in some ways black bass fishing, where you are never sure they will not escape till you have them in the boat.

581		1905	Dec.	24	Tauntonia
599	UJ	1906	Apr.	25	Luisa
600	UM	"	June	14	Musa
602		"	Feb.	16	Marianna
603	TI	"	"	"	Timandra
604	TK	"	"	"	Tekmessa
611	VL	"	Sept.	24	Valeria
620		"	Oct.	26	Drakonia
622	WP	"	Nov.	13	Esther
636	XP	1907	Feb.	8	Erika
637	YE	"	Mar.	11	Chrysothemis
638	ZQ	"	May	5	Moira
653	BK	"	Nov.	27	Berenike
645	AG	"	Sept.	13	Agrippina
655	BF	"	Nov.	4	Briseis
660	CC	"	Jan.	8	Crescentia
661	CL	"	Feb.	22	Cloelia
662	CW	"	Mar.	30	Newtonia
673	EA	"	Sept.	20	Edda
675	DU	"	Aug.	30	Ludmilla
690	HZ	1909	Oct.	16	Wratislavia
691	JG	"	Dec.	11	Lehigh
695	JB	"	Nov.	7	Bella
696	JJ	"	Jan.	10	Leonora
726	NM	1911	Nov.	22	
729	OD	1912	Feb.	9	
736	PZ	"	Nov.	16	
737	QB	"	Dec.	7	
739	QR	1913	Feb.	7	
740	QS	"	"	10	
741	QT	"	"	10	
747	QZ	"	Mar.	7	
755	CZ	1908	Apr.	6	
756	DC	"	"	26	
757	EJ	"	Sept.	30	
767	SX	1913	Sept.	23	
784	UM	1914	Mar.	20	

An Asteroid Instead of a Comet.—The object discovered by Wolf on September 14, 1917, and announced first as Encke's comet, later as a new comet (*c* 1917), seems not to have been a comet but an asteroid or minor planet. It has been given the provisional designation 1917 CP. Dr. F. Cohn of the Berlin "Astronomisches Recheninstitut" has computed the following elliptic elements of its orbit

from observations on September 14 at Königstuhl, September 23 and October 3 at Vienna:

Epoch 1917 October 3.5 G. M. T.

$M_0 = 29° 05'.6$
$\omega = 39 \ 44 .2$ } 1917.0 $\psi = 11° 30'.4$
$\Omega = 285 \ 43 .7$ $\mu = 1057''.9$
$i = 4 \ 43 .7$ $\log a = 0.35038$

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, November-December, 1917.

The meeting for the formal organization of the Association was held at the Harvard College Observatory, Cambridge, Mass., on November tenth. Professor E. C. Pickering, Director of the Observatory, cordially welcomed the twenty-five members who were present, and after the taking of a group picture the business meeting was held at the Director's home through his kind invitation.

Mr. A. B. Burbeck was elected Chairman of the meeting. The constitution and By-Laws were read and adopted, and the following officers elected:

President,	David B. Pickering,
Vice President,	H. C. Bancroft, Jr,
Treasurer,	A. B. Burbeck,
Secretary,	W. T. Olcott.

Members of the Council for two years:

Professor Anne S. Young,
John J. Crane.

Members of the Council for one year:

Miss H. M. Swartz,
C. Y. McAteer.

Various matters relative to the work of the Association were discussed to promote a higher degree of efficiency and several committees were appointed to take charge of different departments of the work. Professor Pickering, to whom the Association is extremely indebted for many past favors, made a substantial contribution to the Treasury for the purchase of a telescope to be owned by the Association and loaned as it seems fit, a gift that is greatly appreciated.

Professor Solon I. Bailey entertained the members with a description of his authoritative work on the Cluster Variables. An interesting collection of lantern slides were presented by Mr. Leon Campbell, and later in the afternoon tea was served by the Director, when our members had the pleasure of discussing our work with their co-workers and meeting the members of the Observatory staff.

An inspection of the wonderfully interesting work of the Observatory followed, and seventeen of our members observed the Variable 213843 SS Cygni with the 12″ Polar telescope. The individual observations will be found in the report and the close agreement was remarkable, the probable error being only 0.12 magnitude.

At a meeting of the Council the following were elected honorary members: Professor E. C. Pickering, Director Harvard College Observatory; Professor J. A. Parkhurst of the Staff of the Yerkes Observatory; Reverend Father J. G. Hagen, Director of the Vatican Observatory, Rome

Variable Star Observations Nov.-Dec., 1917.

October 0 = 2421502 November 0 = 2421533 December 0 = 2421563

001032
S Sculptoris

J.D. 242	Est.	Obs.
1517.9	11.1	δ

001046
X Androm.

1538.5	<12.7	Y

001620
T Ceti

1474.5	5.8	Lt
76.5	5.9	Lt
77.5	5.9	Lt
78.4	5.9	Lt
82.6	5.9	Lt
84.4	5.9	Lt
86.5	6.1	Lt
92.5	6.3	Lt
93.5	6.3	Lt
96.7	6.3	Lt
1502.4	6.3	Lt

001755
T Cassiop.

1476.5	8.8	Lt
92.4	8.7	Lt
1538.8	9.6	M
39.5	9.0	Pi
44.6	10.0	Me
45.9	10.2	Bg

001726
T Androm.

1543.6	12.2	Me
43.7	<10.7	Bg
46.5	<11.8	Pi
46.6	12.2	Wh
47.5	12.3	Y
52.	<10.7	Bl

001838
R Androm.

1474.4	8.2	Lt
76.3	8.1	Vo
77.4	8.3	Vo
78.3	8.3	Vo
78.4	8.2	Lt
79.3	8.4	Vo
79.4	8.2	Lt
82.5	8.4	Lt
84.4	8.4	Vo
86.4	8.3	Vo
86.4	8.5	Lt
92.5	8.8	Lt
96.3	8.8	Lt
99.3	8.9	Lt
1505.2	9.1	Pe
16.3	9.4	Pe
34.5	9.5	B
37.6	10.0	V
38.5	9.9	Y
38.6	9.2	Hu
38.8	9.8	M

R Androm.

J.D. 242	Est.	Obs.
1540.6	10.0	Me
46.5	10.0	Pi
50.8	10.0	M
51.5	10.4	V
52	10.0	Bl

001909
S Ceti

1477.5	8.4	Lt
82.6	8.5	Lt
88.4	8.5	Lt
92.5	8.6	Lt
92.6	8.6	δ
1507.8	9.4	δ
17.9	10.0	δ
35.5	11.2	Pi
37.6	<10.2	S
38.5	11.5	Y
38.8	11.0	M
43.6	<11.8	Bg
46.5	<11.8	De
46.7	11.7	Pi
50.6	11.7	Y

002614
T Piscium

1538.8	11.2	M

003179
Y Cephei

1463.4	12.0	Lt
65.5	11.9	Lt
77.4	11.1	Lt
82.6	10.8	Lt
86.4	10.4	Lt
92.4	10.1	Lt
96.3	10.0	Lt
1535.6	10.2	Wh
38.6	10.0	Hu
40.6	8.1	De
48.6	10.8	Bg
50.7	11.0	Wh
50.7	11.1	M

004047
U Cassiop.

1540.6	<12.8	Me
43.6	14.0	Me
47.5	12.9	Y

004181
RX Cephei

1477.4	7.5	Lt
82.4	7.4	Lt
1502.4	7.5	Lt

004132
RW Androm.

1537.5	10.3	O
46.5	10.2	Pi

RW Androm.

J.D. 242	Est.	Obs.
1549.5	10.3	O
49.6	10.1	De
50.9	10.3	Bg
52	10.0	Bl

004435
V Androm.

1549.5	10.8	O
50.5	11.3	B
50.6	11.0	Hu

004533
RR Androm.

1482.5	10.7	Lt
1549.6	<12.6	De

004958
W Cassiop.

1481.4	9.4	Lt
82.5	9.3	Lt
92.4	9.3	Lt
1537.5	10.0	O
38.6	9.4	Hu
41.7	10.1	Wh
42.6	9.7	Me
49.5	9.9	Y
50.8	10.0	M
52	10.1	Bl

010102
Z Ceti

1476.5	9.5	Lt
77.5	9.4	Lt
82.6	9.1	Lt
88.7	9.0	Lt
92.5	8.9	Lt
1540.6	11.6	Y
52.5	<11.5	Pi

010940
U Androm.

1538.6	9.6	Hu
46.6	10.6	Pi
49.6	10.8	De

011272
S Cassiop.

1540.6	<12.0	Wh
45.9	<10.8	Bg
46.5	<12.3	Pi

011208
S Piscium

1537.6	<11.3	V
38.5	<14.0	B
43.6	<13.6	Me
46.6	<13.6	Y
49.6	<12.0	Wh

011712
U Piscium

1549.6	12.0	Wh

012350
RZ Persei

J.D. 242	Est.	Obs.
1542.6	<12.1	Me
47.5	13.0	Y

012502
R Piscium

1461.5	11.6	Lt
65.5	11.3	Lt
76.5	10.1	Lt
77.5	10.0	Lt
82.6	9.6	Lt
86.5	9.6	Lt
87.6	9.5	Lt
92.5	9.3	Lt
93.5	9.3	Lt
1537.6	<9.8	S

013238
RU Androm.

1546.6	12.3	Pi

013338
Y Androm.

1480.4	9.7	Lt
83.4	9.8	Lt
92.5	11.0	Lt
1546.6	<11.4	Pi

014958
X Cassiop.

1483.4	11.6	Lt
93.4	11.7	Lt
1546.5	11.5	B
47.5	11.9	Y
50.5	11.7	B
58.8	10.7	M

015354
U Persei

1476.4	7.9	Lt
78.3	8.0	Vo
79.3	8.2	Vo
79.4	7.9	Lt
82.3	8.3	Vo
82.6	8.0	Lt
83.3	8.2	Vo
86.4	8.3	Vo
87.3	8.2	Vo
88.3	8.3	Vo
88.4	8.0	Lt
92.3	8.3	Vo
93.3	8.3	Vo
93.4	8.1	Lt
96.3	8.4	Vo
99.3	8.4	Vo
99.3	8.2	Lt
1501.3	8.4	Vo
34.5	8.4	B
37.6	8.6	V
42.6	8.9	Me
44.6	8.8	Wh
45.9	8.9	Bg

U Persei

J.D. 242	Est.	Obs.
1547.7	8.7	Mu
50.8	8.5	M
51.6	8.8	V
56.	8.8	Bl

015912
S Arietis

1546.5	<11.6	Pi
46.6	11.9	B
49.6	12.1	Wh
50.7	<12.0	Bg
62.6	13.0	B

021024
R Arietis

1475.4	9.9	Lt
76.5	10.0	Lt
77.5	9.9	Lt
80.4	9.5	Lt
82.6	9.6	Lt
84.4	9.7	Lt
88.4	9.8	Lt
92.4	9.6	Lt
94.3	9.8	Lt
96.3	9.7	Lt
1537.5	9.5	O
37.6	9.7	S
37.7	9.6	M
41.6	10.2	Me
46.5	9.7	Pi
49.5	9.7	O
52.	9.8	Bl

021143a
W Androm.

1482.5	12.0	Lt
92.5	12.2	Lt
1546.6	<11.9	Pi

021281
Z Cephei

1537.6	<11.5	V

021403
o Ceti

1474.4	5.6	Lt
75.4	5.5	Lt
76.5	5.3	Lt
76.6	4.9	Vo
77.5	5.2	Lt
78.4	5.1	Lt
79.4	5.1	Lt
80.4	4.9	Lt
81.4	4.8	Lt
81.6	4.2	Vo
82.4	4.1	Vo
82.6	4.7	Lt
84.4	4.2	Lt
84.4	4.0	Vo
86.5	3.9	Lt

PLATE II

FORMAL ORGANIZATION MEETING OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS, CAMBRIDGE, MASSACHUSETTS, NOVEMBER 10, 1917.

1 Miss B. H. Vann
2 F. H. Spinney
3 W. J. Delmhorst
4 Miss D. W. Block
5 Mrs. E. T. Brewster
6 L. Campbell
7 Professor A. S. Young
8 Miss S. Raymond
9 Miss L. Allen
10 J. J. Crane
11 Miss D. Reed
12 Miss A. J. Cannon
13 Professor E. C. Pickering
14 E. S. McColl
15 Miss H. S. Leavitt
16 E. T. Brewster
17 Professor S. I. Bailey
18 W. T. Olcott
19 Miss I. E. Woods
20 Rev. T. C. H. Bouton
21 D. H. Wilson
22 H. R. Schulmaier
23 M. J. Jordan
24 A. B. Burbeck
25 Miss I. F. Conant
26 F. L. Ducharme
27 W. H. Reardon

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

o Ceti

J.D. 242	Est.	Obs.
1486.5	4.0	Vo
87.4	3.9	Vo
87.6	3.9	Lt
92.5	3.9	Vo
92.5	3.9	Lt
92.7	3.7	δ
93.4	3.9	Vo
93.5	3.8	Lt
95.4	3.8	Lt
96.4	3.8	Vo
99.3	3.7	Lt
99.4	3.7	Vo
1501.4	3.7	Lt
01.5	3.6	Vo
02.4	3.4	Lt
02.6	3.6	Vo
07.8	3.7	δ
16.3	3.9	Pe
17.2	4.0	Pe
17.9	3.7	δ
25.3	4.1	Pe
26.3	4.1	Pe
35.5	3.9	Pi
38.5	3.9	O
38.6	4.0	B
38.7	3.7	Mu
39.7	3.8	Mu
40.6	3.9	Hu
40.6	3.8	Me
40.7	3.8	Mu
41.7	3.7	Me
41.8	3.9	Mu
42.8	3.6	By
42.8	3.9	Mu
43.6	3.8	Me
43.7	4.0	Mu
44.8	4.0	Mu
45.6	3.8	Me
45.7	4.0	Mu
46.7	4.3	Pi
46.8	4.0	Mu
47.7	4.0	Mu
48.8	4.0	Mu
48.8	4.1	Bg
49.5	3.8	Me
49.5	4.1	O
49.6	4.0	Mu
49.8	3.9	By
50.5	4.5	Nt
50.6	3.9	De
50.7	4.0	By
50.8	4.0	Mu
51.8	4.0	Mu
52.5	4.6	Pi
52.7	4.0	Mu
53.7	4.1	Mu
54.7	4.0	Mu
65.6	5.0	Nt

021558
S Persei

J.D. 242	Est.	Obs.
1535.5	9.8	De
38.5	8.8	B
47.6	9.3	Pi
52.7	8.5	Bg
56.	9.5	Bl

022000
R Ceti

J.D. 242	Est.	Obs.
1546.6	8.4	Y
52.5	8.4	Pi

022150
RR Persei

J.D. 242	Est.	Obs.
1482.5	12.3	Lt
88.4	12.1	Lt
93.4	11.5	Lt
1547.6	9.6	Pi

022813
U Ceti

J.D. 242	Est.	Obs.
1474.5	8.7	Lt
77.5	8.5	Lt
82.6	8.4	Lt
87.6	8.4	Lt
92.6	8.3	δ
93.6	8.3	Lt
1507.8	8.2	δ
17.9	8.7	δ
38.6	8.7	B
46.6	8.7	Re
46.6	9.0	Bu
50.8	9.0	Bg
52.5	9.2	Pi

023133
R Trianguli

J.D. 242	Est.	Obs.
1475.4	6.1	Lt
76.6	6.1	Vo
77.4	6.0	Vo
78.3	5.9	Vo
79.3	5.9	Vo
79.4	6.0	Lt
82.4	6.1	Lt
82.4	6.0	Vo
84.4	6.0	Vo
84.4	6.1	Lt
87.3	5.9	Vo
88.4	6.2	Lt
92.3	6.1	Vo
92.5	6.2	Lt
93.3	6.1	Vo
96.3	6.2	Vo
96.3	6.5	Lt
99.3	6.5	Lt
99.3	6.3	Vo
1501.3	6.5	Vo
35.6	8.5	B
35.8	8.5	M
37.5	8.7	O
40.6	8.5	Hu
41.6	9.0	Mu

R Trianguli

J.D. 242	Est.	Obs.
1546.5	9.1	Pi
48.5	9.0	B
49.5	9.4	O
49.6	8.8	Wh
50.8	9.2	M

024217
T Arietis

J.D. 242	Est.	Obs.
1477.6	9.6	Lt
82.6	9.6	Lt
92.5	9.7	Lt

024356
W Persei

J.D. 242	Est.	Obs.
1537.7	8.7	M
38.6	8.9	Hu
44.6	9.0	Wh
46.6	8.9	Bu
46.6	9.0	Re
47.6	9.4	Pi
47.7	8.8	Mu
50.8	8.9	M
52.6	9.1	Bg
56.	8.7	Bl

030514
U Arietis

J.D. 242	Est.	Obs.
1536.7	<12.2	Wh
38.6	<14.2	B
47.6	<13.1	Y

031401
X Ceti

J.D. 242	Est.	Obs.
1458.5	12.3	Lt
61.5	12.1	Lt
65.6	11.7	Lt
74.5	10.5	Lt
76.5	10.4	Lt
77.5	10.2	Lt
82.6	9.6	Lt
87.7	9.4	Lt
92.5	9.1	Lt
93.6	9.1	Lt
1546.6	9.1	Re
46.6	9.0	Bu

032043
Y Persei

J.D. 242	Est.	Obs.
1487.3	9.3	Vo
1535.8	9.5	M
38.6	8.7	Hu
38.6	9.4	B
47.6	9.8	Pi
47.7	10.2	Mu
50.8	9.3	M
52.6	9.8	Bg
56.	10.0	Bl

032335
R Persei

J.D. 242	Est.	Obs.
1474.4	11.5	Lt
82.5	12.1	Lt
93.4	13.0	Lt
1540.6	12.8	Mc
40.6	<13.6	Y
46.6	<13.6	Y
47.6	<11.0	Pi

033362
U Camelop.

J.D. 242	Est.	Obs.
1574.5	8.4	Lt
75.4	8.3	Lt
77.4	8.3	Lt
79.4	8.3	Lt
82.4	8.4	Lt
83.4	8.4	Lt
84.4	8.4	Lt
86.4	8.4	Lt
88.3	8.4	Lt
92.4	8.4	Lt
93.4	8.4	Lt
96.4	8.4	Lt
99.3	8.4	Lt
1502.4	8.5	Lt
50.8	8.7	M
58.6	7.4	Wh

035915
V Eridani

J.D. 242	Est.	Obs.
1507.8	9.2	δ
17.9	9.1	δ

042209
R Tauri

J.D. 242	Est.	Obs.
1542.8	9.6	M
50.8	9.5	M

041619
T Tauri

J.D. 242	Est.	Obs.
1537.6	<11.3	Wh
47.8	<12.8	M
56.	<11.5	Bl

042215
W Tauri

J.D. 242	Est.	Obs.
1516.4	8.7	Pe
25.4	10.2	Pe
35.7	10.6	Wh
37.8	10.7	M
40.6	11.4	Hu
40.6	11.6	Pi
46.7	<11.4	Bg
50.6	<10.1	We
50.8	11.0	M

042309
S Tauri

J.D. 242	Est.	Obs.
1537.6	<11.3	Wh
47.6	<13.8	B
47.8	<12.8	M
56.	<10.6	Bl

043065
T Camelop.

J.D. 242	Est.	Obs.
1477.6	10.8	Lt
80.4	10.9	Lt
83.4	10.9	Lt
93.5	11.3	Lt
1538.6	<12.2	Re
38.6	<12.2	Bu
40.6	<12.2	Wh
45.7	<11.5	Bg
47.5	13.5	Y
47.8	<11.5	M

043274
X Camelop.

J.D. 242	Est.	Obs.
1474.4	11.8	Lt
76.4	11.6	Lt
77.6	11.5	Lt
79.4	11.0	Lt
80.4	10.8	Lt
82.5	10.4	Lt
84.4	10.1	Lt
86.4	10.0	Lt
88.3	9.8	Lt
92.4	9.4	Lt
94.3	9.3	Lt
96.4	9.1	Lt
1501.3	8.7	Lt
37.5	8.7	O
37.6	9.1	V
38.6	8.6	Re
38.6	8.6	Bu
40.6	9.5	Wh
45.7	9.6	Bg
46.5	9.6	Pi
47.8	9.9	M
49.5	10.0	O
51.6	10.4	V
56.	10.5	Bl

043208
RX Tauri

J.D. 242	Est.	Obs.
1628.8	9.3	By
38.6	9.6	B
38.6	9.1	Re
38.6	9.5	Bu
46.7	9.5	Pi
47.8	9.4	M
50.6	9.3	Hu
50.8	9.1	By
62.6	9.8	B

044617
V Tauri

J.D. 242	Est.	Obs.
1545.6	9.4	B
47.6	9.9	Y
47.8	9.8	M
50.8	9.3	By
50.6	10.2	V
62.6	10.2	B

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

045307
R Orionis
J.D 242 Est. Obs.
1547.6 13.0 Y
47.8<11.2 M

045514
R Leporis
1482.6 9.6 Lt
87.6 9.7 Lt
93.6 9.7 Lt
1507.8 8.4 δ
17.9 8.4 δ
42.8 9.6 M
46.7 8.6 Pi

050022
T Leporis
1507.8 11.3 δ
17.9 10.9 δ
42.8<10.3 M

050003
V Orionis
1542.8<11.2 M
47.6<12.7 Y
50.7<12.3 Wh

050953
R Aurigae
1477.6 9.1 Lt
82.6 9.1 Lt
86.4 9.0 Lt
92.4 8.7 Lt
96.4 8.6 Lt
1502.4 8.0 Lt
34.5 7.5 B
38.6 7.9 Re
38.6 8.2 Bu
43.8 7.9 Bg
50.9 8.0 M

052034
S Aurigae
1538.6 9.6 Re
38.6 9.8 Bu
40.6 9.1 Wh
42.6 9.8 Me
50.9 10.0 M

052036
W Aurigae
1538.6 9.4 Re
38.6 9.3 Bu
40.6 8.9 Wh
50.9 9.2 M

052404
S Orionis
1482.6 12.3 Lt
87.6 12.2 Lt
93.6 12.0 Lt
1540.8 10.6 M
47.6 10.2 Y
47.8 10.4 M

053068
S Camelop.
J.D 242 Est. Obs.
1477.6 8.7 Lt
82.5 8.7 Lt
93.4 8.8 Lt
1501.3 8.8 Lt
38.6 9.4 Re
38.6 9.8 Bu
47.8 9.7 M
49.5 10.0 Y

*053005*a
T Orionis
1540.8 10.8 M
46.6 11.1 Re
46.7 10.8 Bu
46.7 11.0 Pi
47.8 11.0 M
50.7 11.0 Wh

053326
RR Tauri
1538.6 12.4 Bu
40.8<10.5 M

053531
U Aurigae
1538.6 9.1 V
38.6 8.9 Re
38.6 9.4 Bu
40.8 9.5 M
45.7 9.3 Bg
46.6 9.5 Bu
52.6 9.2 V

054319
SU Tauri
1538.7 9.4 V
46.6 9.5 Bu
46.7 9.4 Pi
50.7 9.4 Wh
52.6 9.4 V

054615
RU Tauri
1547.6 12.7 Y

054615
Z Tauri
1547.6<12.7 Y

054920
U Orionis
1465.6 8.2 Lt
77.5 8.5 Lt
82.6 8.7 Lt
92.5 9.0 Lt
1542.8 9.0 M
93.6 9.0 Lt
46.0 10.1 Bg
46.6 10.0 Bu
46.7 10.2 Pi
47.6 10.0 Y
52.6 10.9 Hu

054974
V Camelop.
J.D 242 Est. Obs.
1540.6<12.2 Wh
42.8<12.2 M
47.6 14.0 B
49.5 13.0 Y
50.7<12.2 Wh
60.6<11.6 Wh

055353
Z Aurigae
1477.5 9.8 Lt
79.4 9.8 Lt
82.6 9.7 Lt
92.4 9.7 Lt
1542.8 11.0 M
46.6 11.0 Re
46.6 10.7 Bu
47.5 10.7 Y

060450
X Aurigae
1421.5 12.3? Lt
33.5 12.7? Lt
56.5<12.3 Lt
57.5<11.8 Lt
58.5 12.3 Lt
62.5 12.2 Lt
65.6 11.8 Lt
77.5 10.9 Lt
79.4 10.6 Lt
82.6 10.4 Lt
87.6 10.1 Lt
92.4 9.7 Lt
1538.7 10.3 V
40.6 10.4 Wh
45.6 10.2 B
46.6 10.4 Y
52.7<10.9 V

060547
SS Aurigae
1534.6 10.5 Bu
35.6 11.0 Bu
36.6 12.0 De
36.7 11.5 Wh
37.6 11.2 Bu
37.7 12.4 De
38.6<12.5 Hu
38.6 12.1 Bu
38.6 12.1 Re
38.6 12.3 B
38.7<11.2 V
40.6<12.4 Re
40.6<12.4 Bu
40.6<13.0 De
40.6 12.5 Wh
42.6<12.5 Hu
43.8<12.4 M
45.6 14.0 B
45.6<12.4 Re

SS Aurigae
J.D 242 Est. Obs.
1545.6<12.4 Bu
46.6<13.5 B
46.7<12.4 Pi
47.5<12.4 Y
47.6<13.4 B
49.5<13.0 Y
49.8<12.4 By
50.6<13.7 B
50.7<12.4 Wh

061647
V Aurigae
1540.6 9.6 Wh
49.6 9.0 Bg
54.9 10.5 M

061702
V Monoc.
1507.8 8.2 δ
54.9 7.4 M

062808
Z Monoc.
1507.8 8.6 δ

063159
U Lyncis
1546.6 9.7 Y

063558
S Lyncis
1536.7 12.1 Wh
46.6 12.6 Y
49.7<11.7 Bg

064030
X Gemin.
1457.6 13.0 Lt
82.6 12.9 Lt
92.5 12.7 Lt
93.5 12.6 Lt
1542.8 9.8 M
52.7 9.2 V

064707
W Monoc.
1542.8 10.6 M

065111
Y Monoc.
1482.6 10.2 Lt
87.6 10.0 Lt
93.6 10.0 Lt
1542.8 10.4 M
51.8 10.6 Bg

065208
X Monoc.
1507.8 9.1 δ
35.8 8.4 M

065355
R Lyncis
J.D 242 Est. Obs.
1546.6<13.5 Y

*070122*a
R Gemin.
1476.6 6.6 Vo
77.6 6.6 Lt
81.6 6.5 Vo
82.6 6.6 Lt
86.6 6.5 Vo
87.6 6.4 Lt
92.5 6.5 Lt
93.5 6.5 Lt
96.7 6.6 Lt
96.7 6.6 Vo
1501.7 6.5 Vo
02.6 6.6 Vo
41.8 7.5 M
50.7 7.0 Wh

070122b
Z Gemin.
1541.8<11.6 M
50.7<12.1 Wh

070122c
TW Gemin.
1541.8 8.5 M
50.7 8.2 Wh

071044
L_2 Puppis
1492.7 5.7 δ

070109
V Can. Min.
1541.8 9.3 M

070310
R Can. Min.
1541.8 10.6 M

071713
V Gemin.
1550.7 8.0 Wh
50.9 8.0 M
51.8 8.3 Bg

072708
S Can. Min.
1535.8 7.5 M
40.8 7.8 M
41.8 7.9 M
46.8 8.0 M
48.8 8.4 Bg

072811
T Can. Min.
1546.8<10.6 M
51.8<11.4 Bg

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

073508
U Can. Min.

J.D. 242	Est.	Obs.
1546.8	9.5	M
51.9<11.7		Bg

073723
S Gemin.

1543.7<11.7		Wh
43.8<11.5		M

074323
T Gemin.

1546.8<11.6		M
50.7<11.5		Wh
51.9	11.0	Bg

074922
U Gemin.

1539.7<12.3		Wh
40.8<11.7		M
41.8<11.7		M
42.8<11.7		M
43.8<11.4		M
45.7<12.3		Bu
46.7<11.7		Pi
46.8<11.4		M
47.8<11.7		M
50.7<12.3		Wh
50.8<11.7		M
51.9<11.7		Bg

075612
U Puppis

1507.8<12.3		δ
46.8<	9.8	M

080322
RU Puppis

1507.8	8.8	δ

081112
R Cancri

1547.8	10.5	M

081617
V Cancri

1547.8	11.1	M

081733
T Lyncis

1547.8	10.0	M

082405
RT Hydrae

1547.8	9.0?	M

083019
U Cancri

1547.8<11.9		M

083350
X Urs. Maj.

1550.8	10.6	M

085008
T Hydrae

J.D. 242	Est.	Obs.
1550.9	9.4	M

085120
T Cancri

1550.9	9.2	M
51.9	9.4	Bg

093178
Y Draconis

1547.5<13.6		Y

094211
R Leonis

1493.7	7.6	Lt
96.7	7.6	Lt
1541.8	8.8	M
46.0	8.4	Bg
47.9	8.9	M

095421
V Leonis

1541.9<10.6		M

103012
U Hydrae

1552.0	5.1	Bg

103769
R Urs. Maj.

1474.4	7.8	Lt
75.3	7.9	Vo
76.5	7.9	Lt
77.3	8.0	Lt
77.4	8.1	Vo
78.4	7.9	Lt
79.3	8.1	Vo
79.5	7.9	Lt
82.3	8.2	Vo
83.4	8.0	Lt
84.3	8.2	Vo
84.5	8.0	Lt
92.5	8.0	Lt
93.4	8.4	Vo
93.5	8.0	Lt
96.4	8.0	Lt
1501.3	8.0	Lt
35.8	10.0	M
41.9	10.4	M
45.9	11.3	Bg
47.8	10.8	M
50.8	10.9	M

122532
T Can. Ven.

1550.9	9.8	M

123160
T Urs. Maj.

1474.3	9.0	Lt
76.4	8.9	Lt
77.3	8.8	Lt
T Urs. Maj.		
1478.5	8.5	Lt
80.4	8.5	Lt
81.4	8.3	Lt
83.3	8.2	Lt
84.5	8.2	Lt
86.3	7.9	Lt
87.3	8.0	Lt
89.3	7.8	Lt
92.3	7.8	Lt
93.3	7.7	Lt
96.3	7.6	Lt
99.3	7.8	Lt
1501.3	7.8	Lt
05.2	8.1	Pe
37.5	8.2	M
45.9	8.5	Bg
50.9	8.4	M

123459
RS Urs. Maj.

1537.5<11.3		M

123961
S Urs. Maj.

1477.3	11.0	Lt
79.5	10.8	Lt
80.3	10.5	Lt
81.4	10.2	Lt
86.3	9.8	Lt
88.3	9.4	Lt
92.3	9.1	Lt
94.3	9.0	Lt
96.3	9.0	Lt
99.3	8.7	Lt
1501.3	8.7	Lt
05.2	8.5	Pe
37.5	8.4	M
45.9	8.4	Bg
50.9	8.6	M

131596
V Can. Ven.

1477.3	6.7	Lt
81.4	6.7	Lt
83.3	6.8	Lt
86.3	6.9	Lt
92.3	7.1	Lt
96.3	7.3	Lt
1501.3	7.2	Lt

133273
T Urs. Min.

1479.4	12.6	Lt
92.5	12.7	Lt
93.4	12.7	Lt
96.4	12.7	Lt

134440
R Can. Ven.

J.D. 242	Est.	Obs.
1477.3	8.6	Lt
81.4	8.6	Lt
86.3	8.7	Lt
92.3	8.5	Lt
96.3	8.5	Lt
1501.3	8.4	Lt
37.5	7.5	M
50.9	8.0	M

135576
θ Apodis

1491.5	6.0	δ
92.5	5.9	δ
96.5	6.0	δ
1515.5	6.3	δ
17.5	6.3	δ

130959
R Centauri

1491.5	6.3	δ
1507.5	6.1	δ
15.5	6.2	δ

141567
U Urs. Min.

1477.4	8.9	Lt
83.3	9.0	Lt
93.4	9.0	Lt
1537.6	8.8	S
40.5	8.8	Pi
46.5	8.6	B
50.9	9.8	M

142584
R Camelop.

1476.4	11.8	Lt
77.6	11.7	Lt
80.4	11.1	Lt
82.6	10.7	Lt
84.4	10.5	Lt
86.4	10.2	Lt
88.3	9.9	Lt
92.4	9.6	Lt
94.3	9.5	Lt
96.4	9.3	L
1501.3	9.1	Lt
37.5	8.7	O
40.6	8.6	Wh
49.5	8.7	O
50.9	8.2	M

142539
V Bootis

1477.4	10.6	Lt
78.4	10.7	Lt
83.4	10.7	Lt
87.3	10.7	Lt
93.4	10.5	Lt
1537.5	8.0±M	

143227
R Bootis

J.D. 242	Est.	Obs.
1474.4	7.1	Lt
75.3	6.6	Vo
77.3	7.1	Lt
77.3	6.6	Vo
78.3	6.6	Vo
79.3	6.5	Vo
81.4	6.9	Lt
82.3	6.6	Vo
83.3	6.8	Lt
83.3	6.6	Vo
84.3	6.6	Vo
86.3	6.8	Lt
86.3	6.6	Vo
87.3	6.6	Vo
88.3	6.7	Vo
92.3	6.8	Lt
92.3	6.9	Vo
93.3	7.0	Vo
96.3	6.9	Lt
97.3	7.0	Vo
99.3	7.1	Vo
99.3	7.2	Lt
1501.3	7.1	Vo

144676
R Apodis

1492.5	5.8	δ
1517.5	5.8	δ

151714
S Serpentis

1474.3	8.6	Lt
80.4	8.7	Lt
81.4	8.7	Lt
84.4	8.9	Lt
87.3	9.0	Lt
92.3	9.2	Lt
93.3	9.3	Lt
96.3	9.4	Lt

151731
S Cor. Bor

1481.4	12.6	Lt
83.4	12.5	Lt
92.3	12.7	Lt
96.3	12.7	Lt
1537.5<10.3		M

153378
S Urs. Min.

1480.4	11.4	Lt
92.5	11.3	Lt
1537.6<10.8		We
40.6	10.5	Wh
40.6	10.6	Pi
46.6	9.6	B
49.7	9.9	Bg
56.	9.9	Bl

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

154428
R Cor. Bor.

J.D. 242	Est.	Obs.
1481.4	13.6	Lt
82.4	13.6	Lt
83.4	13.6	Lt
84.3	13.5	Lt
86.4	13.6	Lt
92.3	13.6	Lt
1505.2	12.5	Pe
34.5	10.7	B
35.5	10.6	B
35.6	9.8	Wh
37.5	<10.3	M
38.5	10.4	Y
38.5	10.2	B
39.6	10.5	Bg
42.5	9.7	De
46.4	9.8	Y
50.5	10.4	B
50.6	9.5	Wh

154536
X Coronae

J.D. 242	Est.	Obs.
1474.4	12.5	Lt
78.4	12.0	Lt
81.4	11.5	Lt
83.4	11.1	Lt
86.4	10.8	Lt
88.3	10.3	Lt
92.3	10.3	Lt
96.3	10.1	Lt

154639
V Cor. Bor.

J.D. 242	Est.	Obs.
1481.4	10.7	Lt
88.4	10.1	Lt
92.3	10.4	Lt
1545.6	7.5	Bg

154615
R Serpentis

J.D. 242	Est.	Obs.
1475.3	12.3	Lt
82.4	12.3	Lt
92.3	12.7	Lt

154749
ST Herculis

J.D. 242	Est.	Obs.
1477.4	8.0	Lt
83.4	7.8	Lt
93.4	8.0	Lt

155229
Z Cor. Bor.

J.D. 242	Est.	Obs.
1481.4	11.7	Lt
93.4	12.2	Lt
96.3	12.2	Lt

155847
X Herculis

J.D. 242	Est.	Obs.
1476.4	7.2	Lt
77.4	7.2	Lt
78.4	7.0	Lt
79.4	6.9	Lt

X Herculis

J.D. 242	Est.	Obs.
1480.3	6.9	Lt
81.3	6.9	Lt
82.3	7.0	Lt
83.3	7.1	Lt
84.3	7.0	Lt
86.4	7.2	Lt
87.3	7.2	Lt
88.3	7.2	Lt
89.3	7.2	Lt
92.3	7.2	Lt
93.4	7.2	Lt
96.3	7.2	Lt
99.3	7.0	Lt
1501.4	6.9	Lt
02.3	7.0	Lt
50.5	6.4	Nt
65.6	7.1	Nt

160150
RR Herculis

J.D. 242	Est.	Obs.
1477.4	8.7	Lt
83.4	8.7	Lt
93.4	8.8	Lt

160210
U Serpentis

J.D. 242	Est.	Obs.
1481.4	11.7	Lt
82.4	11.6	Lt
92.3	12.0	Lt

160325
SX Herculis

J.D. 242	Est.	Obs.
1477.3	7.9	Lt
78.4	7.9	Lt
81.4	8.0	Lt
87.3	8.1	Lt
88.4	8.1	Lt
93.4	8.2	Lt
1502.3	8.4	Lt

161138
W Cor. Bor.

J.D. 242	Est.	Obs.
1537.6	8.8	Wh
50.6	8.9	Hu

162119
U Herculis

J.D. 242	Est.	Obs.
1477.3	9.0	Lt
81.4	9.0	Lt
93.4	9.2	Lt
94.3	9.2	Lt
1505.3	9.2	Pe
16.3	9.2	Pe
23.3	9.6	Pe
37.6	9.8	Wh

162112
V Ophiuchi

J.D. 242	Est.	Obs.
1478.4	8.3	Lt
83.3	8.2	Lt
84.3	8.2	Lt
88.3	8.1	Lt
92.3	8.1	Lt
1501.3	8.1	Lt

162542
g Herculis

J.D. 242	Est.	Obs.
1476.4	5.2	Lt
77.4	5.2	Lt
78.4	5.1	Lt
79.4	5.0	Lt
80.3	5.1	Lt
81.3	5.1	Lt
82.3	5.1	Lt
83.3	5.0	Lt
84.3	5.0	Lt
86.4	5.0	Lt
87.3	4.9	Lt
88.3	4.9	Lt
89.3	4.8	Lt
92.3	4.8	Lt
93.3	4.8	Lt
94.3	4.9	Lt
96.3	4.9	Lt
99.3	5.0	Lt
1501.4	5.0	Lt
02.3	5.0	Lt

162807
SS Herculis

J.D. 242	Est.	Obs.
1474.3	9.3	Lt
76.4	9.1	Lt
77.3	9.3	Lt
80.4	8.9	Lt
83.4	9.0	Lt
86.4	9.2	Lt
92.4	9.4	Lt
96.3	9.9	Lt
1537.6	<11.5	Wh

163172
S Urs. Min.

J.D. 242	Est.	Obs.
1477.4	9.5	Lt
79.5	9.5	Lt
80.4	9.5	Lt
82.5	9.5	Lt
88.4	9.5	Lt
92.3	9.5	Lt
1501.4	9.5	Lt
37.5	10.4	M
40.5	10.0	Pi
46.5	9.4	B
49.7	9.4	Bg

163137
W Herculis

J.D. 242	Est.	Obs.
1474.5	9.0	Lt
76.4	9.1	Lt
81.4	8.9	Lt
83.4	8.7	Lt
88.3	8.4	Lt
92.4	8.4	Lt
97.3	8.2	Lt
99.3	8.1	Lt
1534.5	8.9	M
38.5	8.6	B
50.6	9.5	Hu
50.6	9.4	Bg

163266
R Draconis

J.D. 242	Est.	Obs.
1474.4	8.0	Lt
77.4	8.1	Lt
82.4	8.4	Lt
86.3	8.8	Lt
88.4	8.9	Lt
92.3	9.3	Lt
96.3	9.6	Lt
1534.5	11.2	M
37.5	<9.4	S
37.6	<9.8	We
40.6	11.5	De
46.6	11.8	B
50.6	<10.5	Bg

164055
S Draconis

J.D. 242	Est.	Obs.
1482.4	9.1	Lt
93.3	9.1	Lt
1501.3	9.1	Lt
02.4	9.1	Lt
34.5	8.7	M
40.6	8.8	De

164715
S Herculis

J.D. 242	Est.	Obs.
1474.4	10.8	Lt
76.4	10.6	Lt
78.4	10.6	Lt
80.4	10.6	Lt
83.4	10.4	Lt
86.3	10.2	Lt
92.4	9.8	Lt
96.3	9.5	Lt
1538.5	8.2	B
45.6	8.9	Bg
50.6	8.4	Wh

165631
RV Herculis

J.D. 242	Est.	Obs.
1483.3	13.5	Lt
86.5	13.2	Lt
92.4	12.7	Lt
93.4	12.7	Lt
1516.3	11.3	Pe
23.3	10.7	Pe
34.5	10.2	M
50.6	10.2	Hu

171401
Z Ophiuchi

J.D. 242	Est.	Obs.
1478.4	11.5	Lt
81.4	11.5	Lt
92.4	12.0	Lt
96.4	12.2	Lt

171723
RS Herculis

J.D. 242	Est.	Obs.
1477.5	9.4	Lt
83.3	9.6	Lt
92.4	10.0	Lt

RS Herculis

J.D. 242	Est.	Obs.
1516.3	11.6	Pe
36.5	<11.2	V
50.6	<11.6	Wh

172809
RU Ophiuchi

J.D. 242	Est.	Obs.
1545.5	12.4	B
49.5	<11.2	V

173457
TY Draconis

J.D. 242	Est.	Obs.
1502.3	9.3	Pe
16.3	9.5	Pe
23.3	9.6	Pe
26.3	9.6	Pe

175458
UY Draconis

J.D. 242	Est.	Obs.
1482.6	11.1	Lt
92.4	11.0	Lt

175458a
T Draconis

J.D. 242	Est.	Obs.
1482.6	12.2	Lt
92.4	12.0	Lt
1534.5	9.6	M
36.5	9.7	V
50.6	11.0	Bg

175519
RY Herculis

J.D. 242	Est.	Obs.
1477.5	11.7	Lt
83.3	10.9	Lt
84.4	10.8	Lt
88.4	10.7	Lt
92.4	10.6	Lt
1516.4	9.3	Pe
38.5	9.4	B
50.6	9.5	Hu

180565
W Draconis

J.D. 242	Est.	Obs.
1545.6	<13.3	B
50.6	<12.5	Y

180531
T Herculis

J.D. 242	Est.	Obs.
1479.4	13.1	Lt
83.4	13.1	Lt
86.3	12.7	Lt
92.4	12.4	Lt
96.3	12.1	Lt
1510.	10.4	Bl
34.5	7.9	M
35.5	7.8	B
35.5	7.9	De
35.6	7.5	Wh
36.6	7.8	We
37.5	7.8	O
45.6	8.4	Me
50.6	7.8	Hu
50.7	7.9	Bg

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

181136
W Lyrae

J.D. 242	Est.	Obs
1475.3	8.0	Vo
76.3	7.9	Vo
77.4	8.7	Lt
78.3	7.9	Vo
80.3	7.8	Vo
80.4	8.3	Lt
81.4	8.1	Lt
82.3	8.0	Vo
83.4	8.1	Lt
86.3	8.0	Vo
87.3	7.9	Vo
88.3	7.9	Vo
88.4	7.7	Lt
92.3	7.8	Vo
93.3	7.8	Vo
93.4	7.6	Lt
96.3	7.8	Vo
96.4	7.5	Lt
99.3	7.5	Lt
1501.3	7.7	Vo
33.6	9.1	De
34.5	9.3	M
35.6	9.3	Wh
35.6	9.6	We
36.6	9.4	Bg
37.5	9.4	O
48.5	10.4	B

181103
RY Ophiuchi

1477.3	10.2	Vo
77.5	9.7	Lt
79.3	10.3	Vo
82.3	10.4	Vo
83.3	10.2	Lt
84.5	10.3	Lt
92.4	11.0	Lt
1545.5	10.7	B

182224
SV Herculis

1482.4	13.2	Lt
84.3	13.2	Lt
92.4	12.9	Lt

183225
RZ Herculis

1477.5	10.4	Lt
83.3	10.6	Lt
92.4	11.3	Lt
1535.6	<11.9	Wh

183308
X Ophiuchi

1474.4	7.0	Lt
75.4	7.2	Vo
76.3	7.2	Vo
77.4	7.1	Lt

X Ophiuchi

J.D. 242	Est.	Obs.
1482.3	7.3	Vo
82.4	7.2	Lt
84.3	7.2	Vo
88.3	7.2	Vo
88.3	7.4	Lt
92.3	7.4	Vo
93.3	7.4	Vo
93.4	7.5	Lt
99.3	7.8	Lt
99.3	7.6	Vo
1501.3	7.6	Vo
35.5	8.2	De
36.6	8.4	V
36.7	8.3	Bg
38.5	8.5	B
49.5	8.8	V

184134
RY Lyrae

1537.6	9.6	Wh

184243
RW Lyrae

1546.5	11.9?	B

184205
R Scuti

1474.3	5.6	Vo
74.4	5.8	Lt
75.3	5.6	Vo
75.4	5.8	Lt
76.3	5.7	Vo
76.4	5.9	Lt
77.3	5.7	Vo
77.4	6.0	Lt
78.3	5.9	Vo
78.4	6.0	Lt
79.3	6.0	Vo
79.4	6.1	Lt
80.3	6.0	Vo
80.3	6.1	Lt
82.3	6.2	Vo
82.3	6.2	Lt
83.3	6.5	Vo
83.3	6.3	Lt
84.3	6.8	Vo
84.3	6.4	Lt
86.3	7.0	Vo
86.4	6.4	Lt
87.3	7.0	Vo
87.3	6.5	Lt
87.5	6.8	δ
88.3	7.0	Vo
88.3	6.6	Lt
89.3	6.7	Lt
92.3	6.9	Lt
92.3	7.2	Vo
92.5	6.5	δ
93.3	7.1	Vo
93.3	6.9	Lt
94 3	7.2	Vo

R Scuti

J.D. 242	Est.	Obs.
1494.3	7.0	Lt
95.3	7.0	Lt
96.3	7.1	Lt
96.3	7.3	Vo
97.3	7.2	Lt
97.3	7.2	Vo
99.3	7.0	Lt
99.3	7.1	Vo
1500.5	6.6	δ
01.3	6.8	Lt
01.3	7.0	Vo
02.3	6.7	Lt
02.3	7.0	Vo
03.5	6.6	δ
05.2	6.4	Pe
09.5	6.2	δ
15.5	5.7	δ
17.2	6.5	Hd
17.5	5.6	δ
18.2	6.0	Hd
35.5	5.2	Pi
35.6	6.0	We
37.6	5.4	Bu
38.6	5.2	Bu
41.6	5.9	Wh
42.5	5.7	De
50.5	5.6	Nt
50.6	5.7	We
65.6	5.5	Nt

185243
R Lyrae

1474.3	4.2	Lt
76.4	4.2	Lt
77.4	4.2	Lt
78.4	4.2	Lt
79.4	4.2	Lt
80.3	4.2	Lt
81.3	4.2	Lt
82.3	4.2	Lt
83.3	4.2	Lt
84.4	4.2	Lt
86.4	4.3	Lt
87.3	4.2	Lt
88.3	4.2	Lt
92.3	4.3	Lt
93.3	4.3	Lt
94.3	4.2	Lt
96.3	4.2	Lt
99.3	4.2	Lt
1501.4	4.2	Lt
02.3	4.2	Lt

190108
R Aquilae

1474.4	9.6	Lt
82.5	9.8	Lt
93.4	10.5	Lt
96.4	10.5	Lt

R Aquilae

J.D. 242	Est.	Obs.
1534.6	10.0	M
35.5	10.9	B
36.6	<10.7	V
37.6	11.1	Wh
41.6	11.7	Bg

190967
U Draconis

1534.6	9.0	M
42.6	10.1	Hu

190926
X Lyrae

1535.5	9.2	De
36.6	9.3	Bg
52.	8.8	Bl

191007
W Aquilae

1478.3	8.6	Lt
92.4	8.7	Lt

191017
T Sagittarii

1491.5	12.5	δ

191019
R Sagittarii

1491.5	<12.0	δ
1539.6	10.1	Bg

191319
S Sagittari

1498.5	12.0	δ

191637
U Lyrae

1535.5	10.5	De

192576
UX Draconis

1477.5	6.8	Lt
79.5	6.8	Lt
82.6	6.8	Lt
83.3	6.8	Lt
92.4	6.8	Lt
93.5	6.8	Lt

192745
AF Cygni

1474.5	6.7	Lt
76.5	6.8	Lt
77.4	6.8	Lt
79.4	6.8	Lt
82.3	6.8	Lt
86.4	6.9	Lt
92.5	7.1	Lt
97.3	7.2	Lt
99.3	7.2	Lt
1501.3	7.2	Lt

192928
TY Cygni

J.D. 242	Est.	Obs.
1550.5	12.9	Y

193311
RT Aquilae

1537.5	<11.0	M

193449
R Cygni

1474.3	8.6	Lt
74.4	8.6	Lt
78.4	8.5	Lt
79.4	8.5	Lt
82.4	8.5	Lt
86.4	8.6	Lt
92.5	8.6	Lt
93.5	8.6	Lt
96.4	8.6	Lt
1591.4	8.6	Lt
02.4	8.6	Pe
16.3	8.9	Pe
34.6	9.2	M
36.7	9.2	Bg
37.5	9.0	O
37.6	8.2	Hu
37.6	9.6	S
39.5	9.0	Pi
41.6	9.0	Wh
46.5	9.2	De
47.6	8.9	B
49.5	9.4	O
52.	8.5	Bl
52.7	9.4	Bg

193509
RV Aquilae

1537.6	<12.2	Wh

193732
TT Cygni

1510.	7.8	Bl
36.7	8.1	Bg
37.6	8.0	Hu
37.6	8.5	M
39.5	8.1	Pi
42.5	8.1	De
56.	7.9	Bl

194048
RT Cygni

1474.4	11.8	Lt
76.5	11.8	Lt
79.4	11.7	Lt
81.4	11.7	Lt
82.4	11.7	Lt
84.4	11.7	Lt
86.4	11.6	Lt
92.5	11.5	Lt
96.4	10.9	Lt
1534.6	9.3	M
36.7	9.1	Bg
37.5	9.1	O

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

RT Cygni

J.D. 242	Est.	Obs.
1539.5	9.0	Pi
41.6	9.0	Wh
46.5	8.6	De
47.6	8.7	B
49.5	8.5	O
50.7	8.5	By
52	8.5	Bl
52.7	8.7	Bg

194348
TU Cygni

1476.5	10.7	Lt
81.4	10.7	Lt
82.4	10.7	Lt
84.4	10.7	Lt
92.5	10.7	Lt
96.4	10.7	Lt
1534.6	11.6	M
36.7	<10.0	Bg
37.6	12.0	Hu
48.5	<11.7	De
52	<11.2	Bl
52.7	<10.0	Bg

194604
X Aquilae

1535.5	<11.3	Pi
36.5	<12.9	De
37.6	<12.2	Wh
44.5	13.5?	By
52	<11.0	Bl

194632
χ Cygni

1482.3	13.2	Lt
1516.3	<12.2	Pe
37.6	<12.0	Hu
37.6	<11.6	M
38.7	< 9.9	Bg
42.6	11 8	Me
45.6	12.7	B
50.5	<12.3	De
50.6	12.5	B
51.6	12.0	Y

195116
S Sagittae

1537.5	5.7	O
49.5	5.3	O

195849
Z Cygni

1534.6	<11.0	M
39.5	<11.6	Pi
41.6	<12.1	Wh
42.6	12.5	Me
45.6	12.5	B
48.5	<12.1	De
50.6	12.7	Y
50.6	<12.7	De
62.5	12.6?	B

200212
SY Aquilae

J.D. 242	Est.	Obs.
1537.6	<11.8	Wh
45.5	<13.0	B

200357
S Cygni

1465.6	13.0	Lt
78.4	12.4	Lt
82.3	12.2	Lt
86.4	12.0	Lt
92.5	11.8	Lt
96.4	11.6	Lt
1534.6	10.5	Bu
37.6	10.3	M
40.6	10.7	Y
41.6	11.0	Wh
47.6	10.7	B
50.6	11.5	De

200514
R Capricorni

1481.4	11.5	Lt
83.3	11.6	Lt
91.5	12.0	δ
96.4	12.2	Lt

200647
SV Cygni

1510	9.2	Bl
34.6	8.9	Bu
35.6	9.4	We
37.6	9.1	M
37.6	8.2	Hu
39.5	9.2	Pi
47.7	8.9	Mu
52	9.5	Bl

200715a
S Aquilae

1474.5	11.0	Lt
82.5	11.6	Lt
84.3	11.8	Lt
93.4	11.9	Lt
1534.5	10.4	±M
36.5	9.7	De
39.7	9.9	Bg
46.6	10.0	Wh

200715b
RW Aquilae

1534.5	8.8	M
36.5	9.1	De
39.7	9.0	Bg
46.6	9.4	Wh

200747
RX Cygni

1547.7	7.9	Mu

200822
W Capricorni

1491.5	12.8	δ

200812
RU Aquilae

J.D. 242	Est.	Obs.
1545.5	12.1	B
45.6	<11.6	Bg

200916
R Sagittae

1474.5	9.1	Lt
79.5	9.1	Lt
82.5	9.1	Lt
86.5	9.4	Lt
88.4	9.6	Lt
93.4	10.0	Lt
1534.5	9.1	M
36.5	9.2	De
39.7	8.7	Bg
46.6	8.9	Wh

200938
RS Cygni

1474.4	8.9	Lt
77.4	8.7	Lt
79.4	8.7	Lt
82.3	8.8	Lt
86.4	8.9	Lt
92.5	8.9	Lt
1534.6	8.9	Bu
37.6	8.7	M
39.5	8.8	Pi
41.6	8.9	Me
41.6	8.7	Wh

200906
Z Aquilae

1474.5	9.7	Lt
77.5	9.3	Lt
79.5	9.3	Lt
82.5	9.4	Lt
88.4	9.6	Lt
93.4	9.7	Lt
1545.5	13.2	B

201008
R Delphini

1456.5	12.2	Lt
57.4	12.1	Lt
58.5	12.1	Lt
61.5	12.1	Lt
76.5	11.3	Lt
82.5	11.1	Lt
86.4	10.8	Lt
92.4	10.2	Lt
93.4	10.1	Lt
96.4	10.0	Lt
1534.6	8.5	M
34.6	8.7	Bu
34.6	8.4	B
37.5	8.7	O
41.6	8.8	Bg
43.6	8.4	Wh

201130
SX Cygni

J.D. 242	Est.	Obs.
1479.5	9.4	Lt
82.4	9.5	Lt
88.4	9.8	Lt
92.5	10.1	Lt
1532.5	11.6	De
34.6	10.9	Bu
34.6	10.4	M
35.5	10.2	B
47.6	11.0	B
50.6	11.6	Y

201121
RT Capricorni

1491.5	7.1	δ
1539.6	7.8	We
43.6	8.0	Bg

201437b
WX Cygni

1492.5	12.4?	Lt

201647
U Cygni

1478.4	9.9	Lt
82.4	9.9	Lt
93.5	9,8	Lt
1510	9.0	Bl
33.6	9.4	De
34.6	9.6	Bu
37.6	9.2	M
37.6	9.6	S
39.5	9.8	Pi
41.6	10.0	Bg
41.6	10.2	Wh
42.5	10.4	Me
47.7	9.3	Mu
50.6	10.4	De
52	9.5	Bl

202539
RW Cygni

1510	8.5	Bl
34.6	8.9	Bu
37.6	8.5	M
37.6	8.4	Me
39.5	8.4	Pi
41.6	8.6	Bg
41.6	7.5	Wh
59.5	7.6	De

202622
RU Capricorni

1491.5	11.0	δ

202817
Z Delphini

1545.5	13.7	B
46.6	<11.7	Wh

202946
SZ Cygni

J.D. 242	Est.	Obs.
1537.6	9.5	M
38.6	9.5	Bu
41.6	10.0	Wh
52	9.3	Bl

202954
ST Cygni

1535.5	12.3	B
37.6	12.0	Hu
37.6	<11.7	M
38.6	12.3	Bu
39.5	<11.7	Pi
47.6	12.8	B
52.5	12.8	De

203226
V Vulpec.

1537.6	8.9	M
46.6	8.8	Wh
52.5	9.6	Pi
59.5	9.4	De

203611
Y Delphini

1545.5	13.6	B
46.6	<11.7	Wh

203816
S Delphini

1480.4	10.5	Lt
82.5	10.6	Lt
93.4	10.7	Lt
1534.5	10.3	M
40.5	10.7	De
43.6	9.9	Wh
45.6	9.8	B
59.5	10.9	De
62.6	9.8	B

203847
V Cygni

1537.6	<11.7	M
41.7	<11.8	Bg

204016
T Delphini

1482.5	12.9	Lt
93.4	13.2	Lt
1534.5	<11.6	M
37.6	<12.0	Wh
38.6	<12.2	Re
38.6	<12.2	Bu
45.6	<14.0	B

204017
U Delphini

1476.4	6.4	Lt
77.3	6.5	Lt
78.4	6.4	Lt
79.4	6.4	Lt
80.3	6.5	Lt
81.3	6.5	Lt

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1917—Continued.

U Delphini

J.D. 242	Est.	Obs.
1482.3	6.5	Lt
83.3	6.5	Lt
84.3	6.5	Lt
86.4	6.5	Lt
87.3	6.5	Lt
88.3	6.4	Lt
89.3	6.4	Lt
92.3	6.5	Lt
93.4	6.5	Lt
94.3	6.5	Lt
96.3	6.4	Lt
99.3	6,5	Lt
1501.4	6.4	Lt

204215
U Capricorni

1491.5	12.0	δ

204318
V Delphini

1543.6	<11.8	Wh
45.6	<13.0	B

204405
T Aquarii

1478.4	12.9	Lt
82.6	12.9	Lt
93.4	12.6	Lt
1534.5	9.0	M
35.5	8.6	B
43.6	7.5	Bg
52.5	7.8	Pi

204846
RZ Cygni

1537.6	<11.1	M

205030a
UX Cygni

1482.4	11.6	Lt
83 5	11.6	Lt

205017
X Delphini

1540.5	10.3	De
45.6	9.9	B
46.6	9.6	Wh
50.5	9.0	B
52.5	9.6	De

205923
R Vulpeculae

1442.5	11.1	Lt
48.4	11.5	Lt
51.5	11.8	Lt
56.4	11.9	Lt
57.4	12.0	Lt
58.5	11.9	Lt
61.5	12.0	Lt
62.4	12.0	Lt

R Vulpeculae

J.D. 242	Est.	Obs.
1465.5	11.8	Lt
66.4	11.8	Lt
72.5	11.3	Lt
74.4	11.1	Lt
76.5	11.1	Lt
77.4	11.0	Lt
78.4	11.0	Lt
79.4	11.0	Lt
82.5	10.2	Lt
84.5	10.0	Lt
87.3	9.6	Lt
92.5	9.4	Lt
96.4	9.2	Lt
97 3	9.1	Lt
1501.3	8.9	Lt
37.6	8.0	Hu
37.6	8.6	M
41.7	9.0	Bg
46.6	9.0	Wh
50.5	9.2	De
52.5	9.3	Pi

210116
RS Capricorni

1491.6	8.5	δ
1546.6	8.4	Bg

210124
V Capricorni

1491.6	<12.5	δ

210129
TW Cygni

1535.5	<13.0	B
37.6	<11.0	M
47.5	13.8	B

210221
X Capricorni

1491.6	<12.7	δ

210516
Z Capricorni

1491.6	9.7	δ

210868
T Cephei

1475.3	9.0	Vo
76,3	8.8	Vo
78.3	8.6	Vo
79.3	8.5	Vo
80.3	8.5	Vo
82.3	8.4	Vo
82.4	9.0	Lt
86.5	8.9	Lt
92.3	8.3	Vo
92.4	8.9	Lt
93.3	8.3	Vo
96.3	8.2	Vo
99.3	8.1	Vo

T Cephei

J.D. 242	Est.	Obs.
1501.3	8.1	Vo
02.3	8.2	Vo
02.4	8.7	Lt
37.5	8.0	O
37.6	7.9	M
40.6	8.1	De
41.7	7.0	Wh
46.6	7.2	Hu
50.6	8.0	We
50.7	7.9	Bg

211615
T Capricorni

1491.6	<9.7	δ

213244
W Cygni

1474.4	6.2	Lt
76.4	6.3	Lt
77.4	6.4	Lt
78.4	6.4	Lt
79.4	6.4	Lt
80.3	6.4	Lt
81.3	6.5	Lt
82.3	6.5	Lt
83.3	6.5	Lt
86.4	6.5	Lt
87.3	6.5	Lt
88.3	6.6	Lt
92.3	6.6	Lt
93.3	6.6	Lt
96.3	6.7	Lt
99.3	6.6	Lt
1501.4	6.7	Lt
02.4	6.6	Lt
16.3	6.4	Pe

213678
S Cephei

1476.4	10.2	Lt
88.3	10.4	Lt
86.4	10.5	Lt
93.5	10.5	Lt
1537.6	<10.2	M
40.6	11.6	De
40.6	11.3	Wh
46.6	9.6	Hu

213753
RU Cygni

1477.4	8.6	Lt
82.4	8.5	Lt
93.5	8.4	Lt
1501.4	8.2	Lt
37.7	8.6	M
41.7	7.7	Bg

213843
SS Cygni

1474.4	11.7	Lt
75.4	11.8	Lt

SS Cygni

J.D. 242	Est.	Obs.
1476.4	11.8	Lt
77.4	11.8	Lt
78.4	11.9	Lt
79.4	11.9	Lt
80.4	11.9	Lt
81.4	11.9	Lt
82.3	11.9	Lt
83.3	11.9	Lt
84.3	11.8	Lt
86.3	11.9	Lt
87.3	11.9	Lt
88.3	11.9	Lt
89.3	11.9	Lt
92.3	11.9	Lt
93.4	11.9	Lt
94.3	11.9	Lt
95.3	11.9	Lt
96.3	11.8	Lt
97.3	11.8	Lt
99.3	<9.6	Lt
1501.4	<9.6	Lt
02.4	<9.6	Lt
34.5	9.8	M
34.6	9.6	B
34.6	9.8	O
34.6	9.9	Bu
35.5	10.2	Pi
35.6	9.7	Bu
35.6	9.8	B
35.6	9.8	Wh
35.8	10.0	M
36.6	10.5	V
36.6	10.2	De
37.5	10.4	O
37.6	10.9	Wh
37.6	10.9	Bu
37.6	< 9.6	S
37.6	10.4	De
37.6	10.4	M
38.6	10.9	B
38.6	11.6	Re
38.6	10.5	V
38.6	10.9	Hu
38.6	11.2	Bu
39.5	10.9	Pi
40.5	11.4	Pi
40.6	11.0	Y
40.6	11.9	Re
40.6	11.0	Hu
40.6	11.9	Bu
40.6	11.5	De
40.8	<10.9	M
41.6	11.3	Wh
41.6	10.6	Me
41.7	11.4	Bg
42.5	10.9	De
42.5	10.8	Me

SS Cygni

J.D. 242	Est.	Obs
1542.6	11.6	Hu
43.5	11.1	Pi
43.5	11.0	B
43.5	11.0	Cr
43.5	11.2	Y
43.5	11.2	O
43.5	11.1	Sp
43.5	11.3	Hu
43.5	11.5	Jd
43.5	11.1	R d
43.5	11.5	Bu
43.5	11.6	Re
43.5	10.9	Mc
43.5	11.2	D
43.6	11.0	Me
44.6	11.1	Me
45.5	11.4	B
45.6	11.8	Re
45.6	11.2	Me
45.6	11.9	Bu
46.5	11.5	Pi
46.6	11.5	Re
46.6	11.2	Wh
46.6	11.7	Bu
46.6	11.2	B
47.6	11.6	Bu
47.6	11.2	B
47.7	<10.9	Mu
48.5	11.1	Pi
49.5	<10.4	O
49.5	<11.3	V
50.6	11.4	B
51.7	<11.3	M
52	11.5	Bl
52.5	11.8	Pi
62.5	11.6	B

213937
RV Cygni

1537.6	7.5	Hu
39.5	7.9	Pi
40.8	8.3	M
41.7	8.1	Bg
52	7.5	Bl

214024
RR Pegasi

1536.5	9.3	De
43.6	9.4	Wh

215605
V Pegasi

1543.7	9.3	Wh

215717
U Aquarii

1491.6	<12.1	δ
1507.7	<11.7	δ

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1917—Continued.

215934
RT Pegasi

J.D.	Est.	Obs.
242		
1536.6	<11.3	V
46.6	11.1	Y

220133a
RY Pegasi

1482.6	12.0	Lt
92.6	12.0	Lt

220133b
RZ Pegasi

1482.6	11.8	Lt
92.4	11.5	Lt

220613
Y Pegasi

1537.6	10.7	V
46.6	10.9	Y
50.5	11.2	V

220714
RS Pegasi

1537.6	<10.9	V
46.6	12.4	Y

221321
X Aquarii

1491.6	9.5	δ
1507.7	10.8	δ

221722
RT Aquarii

1492.6	10.5	δ
1507.7	10.5	δ

222439
S Lacertae

1475.4	8.2	Vo
77.4	8.4	Vo
79.4	8.5	Lt
82.4	8.5	Lt
82.4	8.5	Vo
88.4	8.4	Lt
93.5	8.5	Lt
99.3	8.6	Lt
1541.6	10.2	Wh

223841
R Lacertae

J.D.	Est.	Obs.
242		
1482.5	10.6	Lt
88.4	10.8	Lt
1546.6	<13.0	Y

225120
S Aquarii

1492.6	<12.8	δ
1507.7	<12.7	δ
16.7	<13.0	δ
38.5	<12.8	Y
46.6	<13.5	B
52.5	<10.7	Pi

225914
RW Pegasi

1477.5	12.0	Lt
82.6	11.8	Lt
86.4	11.5	Lt
92.4	11.0	Lt
96.3	10.9	Lt
1538.6	11.5	V
43.6	11.7	Wh
47.7	10.9	Mu
50.6	12.0	B
52.5	11.8	De

230110
R Pegasi

1482.6	13.0	Lt
86.4	12.7	Lt
92.4	12.5	Lt
96.4	12.4	Lt
1505.2	12.1	Pe
23.3	11.9	Pe
37.5	11.1	M
39.5	10.1	Pi
40.6	10.0	Hu
41.6	11.3	Me
41.8	9.8	Bg
43.6	10.1	Wh
47.6	10.1	We
49.5	9.9	O

230759
V Cassiop.

J.D.	Est.	Obs.
242		
1475.3	7.1	Vo
76.3	7.1	Vo
77.4	7.2	Lt
78.3	7.1	Vo
78.4	7.2	Lt
79.3	7.1	Vo
80.3	7.0	Vo
82.3	7.1	Vo
82.4	7.1	Lt
86.3	7.2	Lt
87.3	7.2	Vo
88.3	7.1	Vo
88.4	7.2	Lt
92.3	7.3	Vo
92.5	7.3	Lt
93.3	7.2	Vo
94.3	7.4	Vo
96.3	7.4	Vo
99.3	7.7	Vo
99.3	7.9	Lt
1501.3	7.9	Vo
02.3	8.0	Vo
37.5	9.8	O
38.5	10.0	Hu
41.6	10.2	Wh
41.8	10.6	Bg
42.6	10.3	Me
56	11.2	Bl

231425
W Pegasi

1549.5	<11.5	V

231508
S Pegasi

1542.6	11.1	Me
44.6	10.8	Wh
50.6	10.7	B

231917
RU Aquarii

1492.6	9.3	δ
1507.7	9.1	δ
16.7	9.6	δ

233335
ST Androm.

J.D.	Est.	Obs.
242		
1534.5	10.1	B
38.6	10.0	Hu
40.6	11.0	Re
40.6	11.2	Bu
45.7	10.9	Bg
46.5	10.9	Pi
52	10.5	Bl

233815
R Aquarii

1476.5	8.5	Lt
77.5	8.3	Lt
78.4	8.3	Lt
79.5	8.1	Lt
82.6	7.9	Lt
84.4	7.5	Lt
86.5	7.2	Lt
92.6	6.5	δ
92.5	6.6	Lt
96.7	6.6	Lt
1501.4	6.4	Lt
02.4	6.5	Lt
07.7	6.3	δ
16.7	6.2	δ
17.7	6.3	δ
38.5	7.4	Y
52.	7.2	Bl

234716
Z Aquarii

1477.5	8.8	Lt
79.5	8.7	Lt
82.6	8.4	Lt
86.5	8.4	Lt
92.5	8.4	Lt
92.6	8.3	δ
1502.4	8.4	Lt
07.7	8.5	δ
17.7	8.7	δ

235053
RR Cassiop.

1546.5	11.4	Y

235182
V Cephei

J.D.	Est.	Obs.
242		
1477.4	6.2	Lt
82.4	6.2	Lt
1502.4	6.3	Lt

235350
R Cassiop.

1480.4	12.7	Lt
82.5	12.8	Lt
84.4	12.9	Lt
86.4	12.8	Lt
92.4	12.8	Lt

235525
Z Pegasi

1537.5	8.6	O
37.6	8.7	V
38.5	8.6	Y
43.6	8.7	Wh
45.5	8.6	O
49.5	8.8	V

235715
W Ceti

1465.6	10.1	Lt
74.5	10.4	Lt
92.6	12.4	δ
1507.7	13.4	δ
17.7	<13.5	δ

235855
Y Cassiop.

1538.5	12.1	Y

235939
SV Androm.

1538.5	<12.7	Y
38.5	13.0	B
46.5	<12.3	Pi

No. of Observations 1932; No. of Stars Observed 263; No. of Observers 24.

Professor Pickering was elected the first Patron of the Association, and the following Members, having paid the proper fee, were elected life members from the total membership of eighty-eight: J. J. Crane, S. C. Hunter, W. P. Meeker, W. T. Olcott, C. Pardo, D. B. Pickering, Rev. Victor Stepka, Miss H. M. Swartz, H. R. Schulmaier.

Mr. H. R. Schulmaier of Berwick, Me., was appointed Historian.

At 8:00 P. M. the party proceeded to Boston, where a sumptuous banquet was served. Interesting speeches were made by Professor Pickering, Professor Bailey,

Miss Cannon, Mr. Leon Campbell and President Pickering. The thanks of the Association are due Messrs. Campbell and Burbeck for the admirable arrangements for the banquet which was greatly enjoyed by all. The souvenir of the occasion was a splendid print of the Orion Nebula.

The following day a number availed themselves of the courteous invitation of Professor McAdie to visit the famous Blue Hill Observatory. We were favored with delightful weather and the trip was most enjoyable.

This meeting of the Association marks an epoch in the history of the organization which is now fully launched on its career of usefulness. We have a carefully drawn up Constitution and By-laws to govern the body and a highly satisfactory membership which should, through the medium of the annual dues, permit us to greatly increase the scope and efficiency of the work.

Mr. John J. Crane of Sandwich, Mass., of the Committee on Charts, wishes members to inform him:—

First, as to what they consider is the best type of Chart for general use.

Second, Any discovered errors in the Charts.

Third, Comparison stars suspected of variability.

Members will confer a favor by complying with this request, as it is most important that we decide as soon as possible on the standard type of chart that will be free from the errors and defects of the present set.

The annual dues of $2.00 are now payable and should be promptly remitted to the Treasurer, Mr. Allan B. Burbeck, N. Abington, Mass.

The opportunity for interested persons to enroll as Charter Members of the Association will remain open until December 31st. Members are urged to bring this matter to the attention of any telescopists of their acquaintance.

Through the courtesy of Mr. C. H. Barns of Morgan Hill, Cal., who has kindly offered to print the material, we hope to send each member of the Association in the near future a pamphlet containing the Constitution and By-laws and a list of officers and members of the Association.

The following are the Julian dates for the designated months of 1918:

January	0	2421594	July	0	2421775
February	0	625	August	0	806
March	0	653	September	0	837
April	0	684	October	0	867
May	0	714	November	0	898
June	0	745	December	0	928

Mr. Dawson contributes a valuable set of 74 observations of 38 Southern Variables. Mr. McAteer deserves credit for his list of 146 estimates of 120 Variables. The prize list this month was contributed by Mr. Luyten, 789 observations of 125 Variables, which well attests the zeal and interest of the observer.

Members are requested to note on their lists each month the number of observations and the number of stars observed. We hope soon to issue blank forms for recording observations. Members can facilitate the work of copying their lists by making carbon copies, forwarding the original to the Harvard College Observatory and sending the copy to the Secretary on the first day of each month.

The following members contributed to this report: Messrs. Baldwin, Bolfing, Bouton, Burbeck, Bryan, Dawson, Delmhorst, De Perrot, Houdard, Hunter, Luyten, McAteer, Meeker, Mundt, Nolte, Olcott, D. B. Pickering, Reardon, Miss Swartz, Vogelenzang, Vrooman, Miss Weber, Whitehorn, Miss Young.

WILLIAM TYLER OLCOTT,
Secretary.

Norwich, Conn.
December 10, 1917.

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes and Franz Exner at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1918 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8			11 8					
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	7 12;	15 4;	22 21					
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	8 7;	15 17;	23 3					
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	1 2;	8 14;	16 1;	23 13				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	2 11;	8 14;	20 19;	26 22				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	1 3;	8 7;	15 10;	22 14				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	2 22;	9 19;	16 16;	23 12				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	7 1;	14 5;	21 9;	28 13				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	8 21;	17 16;	26 11					
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	8 21;	16 20;	24 18;	4 17				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6			22 12					
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	2 19;	8 13;	20 0;	25 17				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	2 4;	8 23;	15 18;	23 13				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	8 8;	16 5;	24 3					
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	3 16;	11 23;	20 6;	28 14				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	4 7;	12 4;	20 1;	27 13				
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	3 9		16 14					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	1 23;	11 9;	20 20;	27 3				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1		11 12;	23 23					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	6 10;	13 2;	19 18;	26 10				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	7 19;	15 23;	24 4					
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4 1;	10 2;	23 3;	28 3				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	5 8;	13 24;	22 16					
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	1 13;	11 23;	22 9					
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	2 15;	10 16;	18 16;	26 16				
RW Gemin.	5 35.4	+23 08	9.5—11.0	2 20.8	4 12;	10 6;	21 17;	27 11				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	1 6;	6 20;	18 1;	23 15				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	3 10;	11 15;	19 20;	28 1				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	5 1;	12 16;	20 7;	27 22				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	7 12;		19 17					
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	5 5;	12 9;	19 13;	26 17				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	1 6;	8 1;	21 17;	28 12				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	8 5;	17 12;	26 20					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	3 7;	9 22;	16 12;	23 3				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	4 5;	12 15;	21 0					
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	7 1;	13 11;	19 22;	26 8				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	6 19;	14 2;	21 8;	28 15				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	5 15;	13 17;	21 20					
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	4 14;	14 2;	23 14					
RX Hydrae	9 00.8	— 7 52	9.1—10.5	2 6.8	1 14;	8 11;	22 3;	29 0				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	6 4;	12 2;	18 1;	23 23				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	4 6;	11 0;	17 18;	24 12				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	1 16;	9 2;	16 12;	23 22				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	1 20;	8 10;	21 15;	28 5				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	9 15;	18 10;	27 5					
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	7 21;	15 5;	22 13					
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	1 2;	7 21;	21 10;	28 5				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	2 3;	9 15;	17 3;	24 15				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.2	6 3;	15 17;	25 8					
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	2 23;	10 10;	17 20;	25 7				
δ Librae	14 55.6	— 8 07	4.8— 6.2	2 07.9	5 11;	12 11;	19 10;	26 10				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1918 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	4 10;	11 8;	18 5;	25 3				
TW Draconis	32.4	+64 14	7.3— 8.9	2 9.12	1 0;	9 11;	17 21;	26 7				
SS Librae	15 43.4	—15 14	9.3—11.5	0 18.4	4 17;	12 8;	28 0;	27 16				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	2 3;	9 11;	16 19;	24 3				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	5 11;	13 17;	21 23					
R Arae	31.1	—56 48	6.8— 7.9	4 10.2	2 13;	11 10;	20 6					
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	5 7;	15 0;	26 1					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	6 8;	13 3;	19 23;	26 18				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	1 7;	9 16;	18 2;	26 11				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	4 2;	10 6;	22 13;	28 17				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	2 15;	9 20;	17 1;	24 6				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	5 6;	12 15;	20 0;	27 9				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	3 12;	11 17;	19 21;	28 1				
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	5 17;	13 6;	28 19;	28 8				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 4;	10 22;	18 16;	26 10				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	1 21;	9 20;	17 20;	25 20				
WX Sagittae	53.6	—17 24	9.2—10.8	2 03.1	9 5;	17 17;	26 6					
WY Sagittae	17 54.9	—23 1	9.5—10.6	4 16.0	3 20;	13 4;	22 13					
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	4 20;	15 4;	25 12					
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	5 1;	12 7;	19 13;	26 19				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	2 2;	9 0;	15 22;	22 20				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		11 20;		26 23				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	4 16;	11 20;	19 0;	26 4				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	2 11;	9 14;	16 17;	23 20				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	3 17;	12 0;	20 7;	28 15				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 0;	13 12;	22 0					
AZ Ophiuchi							23 19					
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	4 8;	10 23;	17 15;	24 6				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	6 10;	19 7						
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	4 19;	12 10;	20 1;	27 17				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	8 8;	15 22;	23 11					
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	7 13;	14 18;	21 23					
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	2 3;	11 1;	20 0;	28 23				
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	1 15;	8 9;	21 22;	28 16				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	6 10;	13 19;	21 3;	28 12				
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	1 1;	11 13;	22 1;	27 7				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5 14;	12 3;	18 15;	25 4				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	5 4;	11 4;	17 4;	23 5				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	4 10;	11 1;	17 17;	24 8				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	7 17;	16 21;	26 0					
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	1 0;	9 10;	17 21;	26 7				
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	6 10;	13 5;	19 23;	26 18				
UW Cygni	19.6	+42 55	10.5—10.8	3 10.8	4 12;	11 10;	18 7;	25 5				
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	1 10;							
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	4 17;	14 7;	23 22					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	3 7;	12 11;	21 16					
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	3 6;	10 18;	18 5;	25 17				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	1 8;	8 22;	16 12;	24 3				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	5 17;	15 20;	25 22					
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	2 21;	10 6;	17 16;	25 1				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	1 4;	10 21;	20 13					
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	3 20;	11 17;	19 14;	27 10				
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7		11 3;	21 7					
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	3 21							
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	3 8;	8 12;	13 17;	24 1				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	3 15;	11 22;	20 5;	28 12				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	2 22;	10 11;	18 0;	25 13				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	5 2;	13 8;	21 14					

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1918. February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7			17 0					
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	6 12;	14 15;	22 18					
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 0;	9 18;	17 12;	25 6				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2			10 17;		25 12			
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	6 15;	14 14;	22 12					
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	8 14;	16 9;	24 4					
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	5 18;	13 1;	20 8;	27 15				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	8			24				
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	4 8;	12 22;	21 12					
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1		11 21;	23 0					
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	4 1;	15 16;	27 7					
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	3 21;	11 12;	19 4;	26 20				
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	9 19		19 22					
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	8 15;	16 8;	24 2					
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	5 23;	11 12;	22 13;	28 2				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	1 15;	9 4;	16 18;	24 7				
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	2 1							
RT Aurigae	23.0	+30 33	5.1— 6.0	3 17.5	7 5;	14 16;	22 3					
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	4 11;	11 16;	18 21;	26 2				
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	8 14;	16 12;	24 10					
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 1;	12 4;	22 8					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	12 06.5	3 14;		25 21					
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	5 11;	13 9;	21 8					
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	3 3;	9 20;	16 13;	23 5				
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	4 0;	13 7;	22 13					
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	5 11;	14 4;	22 22					
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	5 18;	12 12;	19 7;	26 2				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	7 3;	13 18;	20 9;	27 0				
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	9 14;	19 5;	28 21					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	2 15;	10 14;	18 14;	26 13				
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	7 15;	14 8;	21 2;	27 19				
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	1 23;	7 18;	19 10;	25 6				
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	5 7;	9 23;	19 9;	28 18				
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5		12 9						
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	1 10;	9 15;	17 20;	26 0				
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	6 15;	13 16;	20 16;	27 17				
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	7 22;	16 3;	24 8					
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	4 6;	9 18;	20 17;	26 5				
RS Bootis	29.3	+32 11	8.6—10.0	0 09.1	6 8;	13 21;	21 10;	28 23				
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	6 15;	14 1;	21 11;	28 21				
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	5 20;	12 14;	19 9;	26 4				
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	6 1;	12 9;	18 17;	25 0				
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	6 21;	16 15;	26 10					
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	7 22;	16 18;	25 15					
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	2 18;	8 20;	20 23;	27 0				
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	7 2;	14 2;	21 3;	28 3				
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9		12 12;						
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	5 22;	13 12;	21 2;	28 16				
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	4 13;	10 7;	21 20;	27 15				
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	7 14;	14 8;	21 2;	27 20				
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3		10 15;	20 23					
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	4 17;	10 17;	22 19;	28 20				

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1918. February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	
RZ Lyrae	18 39.9	+32 42	9.9—11.2	0 12.3	3 8;	9 11;	21 17;	27 21				
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	5 18;	11 17;	17 16;	23 15				
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	4 20;	13 23;	23 1					
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	1 7;	8 7;	15 8;	22 9				
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	6 1;	13 1;	20 1;	27 1				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	4 16;	12 16;	20 15;	28 15				
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	7 13;	15 6;	22 22					
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	5 10;	12 14;	19 19;	26 23				
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	6 3;	14 12;	22 21					
X Vulpec.	19 53.3	+26 17	9.51—0.5	6 07.7	3 7;	9 15;	22 6;	28 14				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	2 17;	19 2						
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4 20;	9 6;	18 3;	22 14				
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	1 8;	8 2;	21 13;	28 6				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	5 21;	12 14;	19 7;	26 1				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4		12 11		27 4				
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	3 19;	11 15;	19 12;	27 9				
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	4 6;	11 4;	18 1;	24 22				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	3 17;	8 14;	18 7;	28 1				
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	4 18;	13 9;	22 1					
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	4 16;	10 1;	20 19;	26 4				
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	5 15;	16 12;	27 10					
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	5 15;	12 1;	18 11;	24 21				
V Lacertae	22 44.5	+55 48	8.5— 9.5	4 23.6	5 4;	10 4;	20 3;	25 3				
X Lacertae	45.0	+55 54	8.2— 8.6	5 10.7	3 21;	9 8;	20 5;	25 16				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	3 2;	8 12;	19 10;	24 20				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	2 1;	8 8;	20 22;	27 5				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	3 22;	16 1;	28 5					
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.6	4 21;	9 20;	19 20;	24 19				

Variable Star Y Leonis.—In the *Bulletin Astronomique* for August-October 1917, M. M. Luizet gives the results of his observations of this star from 1908 to 1917, a total of 498. From a discussion of these observations it appears that the elements assigned to this star are slightly in error and new elements are assigned as follows;

$$\text{Min.} = 2418054.4223 + 1^d.686097\,E$$

The variation in brightness has the range from $9^m.3$ to $11^m.4$ approximately

Variable Star Y Aurigae.—M. M. Luizet in the *Bulletin Astronomique* discusses a series of 442 observations of the variable *Y Aurigae*, made by himself from 1905 to 1907 and later from 1909 to 1916. He deduces elements as follows:

$$\text{Max.} = 2415421.173 + 3^d.85916E.$$

This represents a slight shifting of the epoch although a change of only $+0^d.00016$ in the period.

GENERAL NOTES.

Dr. Samuel G. Barton of the University of Pennsylvania has been conducting the U. S. Navigation School at Philadelphia since August, 1917. For a short time prior to this **Prof. Eric Doolittle** of the University of Pennsylvania, and **Prof. S. A. Mitchell** of the University of Virginia, taught the classes.

Astronomy in The Smithsonian Report for 1916—Four interesting popular lectures on astronomical subjects have been printed in the Smithsonian Report for 1916, and also issued as separates from that volume. Their titles and authors are as follows:

"News from the Stars", by C. G. Abbot, director Astrophysical Observatory, Smithsonian Institution.

"The Distances of the Heavenly Bodies", by W. S. Eichelberger, director Nautical Almanac Office, U. S. Naval Observatory.

"A Census of the Sky", by R. A. Sampson, Astronomer Royal for Scotland.

"On the Origin of Meteorites", by Friedrick Berwerth, (translated from the German).

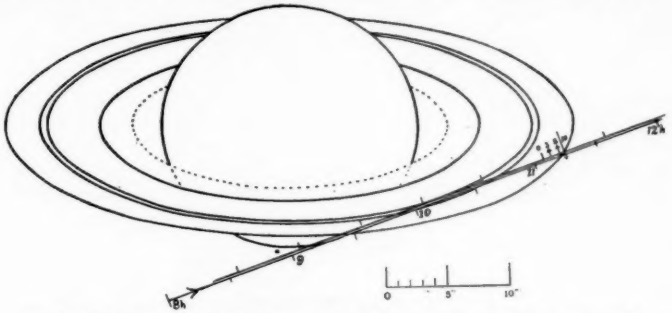
Wireless Time Service in the Philippine Islands.—The progress in the time service of the Philippine Islands is made evident from the fact that since October 1st, 1917, the Cavite Radio Station, co-operating with the Bureau of Posts and the Manila Observatory, sends out time signals of the 120th meridian East of Greenwich at 11 a. m. and 10 p. m. every day, Sundays and holidays inclusive. Manila holds an enviable portion in the Pacific and the interests of shipping companies making Manila a port of call are too impotrtant to be overlooked. Accurate time signals and wise typhoon warnings are of immense value to the units of the United States Asiatic Fleet, to Army transports and in general to oversea shipping.

For the purpose of sending time signals, the transmitting clock of the Manila Observatory is connected with the Cavite Wireless Station through the Bureau of Posts. Manila Observatory time signals begin at 10:55 a. m. and 9:55 p. m. standard time of the 120th meridian East of Greenwich, and continue for five minutes. During this interval every tick of the clock is transmitted, except the 28th, 29th, 54th, 55th, 56th, 57th, 58th and 59th of each minute. Experiments made on board the U. S. Wilmington, Monterey, Sheridan, Merrit and the commercial steamer Colombia of the Pacific Mail, gave satisfactory results.

M. SELGA.

Occultation of a Star by Saturn's Rings.—In the *Journal of the British Astronomical Association* for May 1917 is given the account of the observation of a unique phenomenon by two observers, Messrs. M. A. Ainsle and J. Knight. On the night of February 9, 1917, a star of about the seventh magnitude was watched while the Ring A and the Cassini Division of Saturn's Rings passed by it. Its apparent path through the rings is shown in the occompanying

diagram which is reproduced from a larger diagram in the "*Journal*". Both observers state that the star could be seen all the time it was watched except during



Occultation of the star BD +21°1714 by Saturn's Ring, 1917, February 9.

moments of bad seeing. Its light when behind Ring A was diminished to about one quarter of its normal brightness, and its color was apparently changed from golden yellow to cream white. While seen through the Cassini division it was almost as bright as when entirely clear of the Planet. As it was passing the outer parts of Ring A there were two moments, lasting half a second or more, when the star brightened but did not regain its full brightness; these were probably when the star passed the Encke Division and possibly another minor division in the ring outside of that. The recovery of brightness of the star as it passsed clear of the ring was not instantaneous but occupied perhaps a half second of time.

The interest which attaches to these observations is chiefly on account of what they indicate as to the structure of Saturn's outer ring. Estimating the apparent diameter of a star disk to be one thousandth of a second of arc (which is a large estimate), the distance subtended by this arc at the distance of Saturn would be about four miles. The particles of which Ring A is composed must be much less than four miles in diameter or there would have been many complete disappearances of the star. Here is thus a new confirmation of the theoretical prediction that the rings of Saturn are composed of small separate particles. The particles are small enough and far enough separated to allow about one fourth of a star's light to pass through the thickness of the ring, which augmented by the inclined line of passage may be 100 miles or more.

Stellar Motions and Absolute Magnitude.—In *Contributions from the Mount Wilson Solar Observatory* No. 131 Messrs. Walter S. Adams and Gustaf Strömberg give the results of their study of the radial and proper motions of 1300 stars in connection with their absolute magnitudes. By "absolute magnitude" is meant the brightness, on the Harvard Scale of Magnitudes, which a star would have if it were removed to a distance where its annual parallax would be 0″.1. Thus α *Centauri* is reckoned of magnitude 0.2, but its parallax is 0″.75; if it were removed to 7.5 times its actual distance so that the parallax would be only 0″.1, its brightness would be only one fifty-sixth of its present brightness and its "absolute magnitude" would then be 4.6 instead of 0.2. *Sirius*, the brightest of stars, has an absolute magnitude of 1.3, whereas its apparent magnitude is −1.6.

Adams and Strömberg reach the conclusion that "Radial velocity is a function

of absolute magnitude for the 1300 stars used in this investigation. The increase in velocity is about 1.5 km for a decrease in brithtness of one magnitude." That is, at the same distance the fainter stars have the greater velocities.

This is a remarkable discovery, if it be true, and points to a difference in the action of gravitation upon matter in different stages of temperature and condensation.

The writers say that "this effect cannot be ascribed to distance from the sun, since stars at the same distance show the effect strongly.

"It cannot be due to the law of frequency-distribution of velocities, since the τ-component velocities (cross-velocities) calculated under no assumption of the the frequency-law show the effect equally with the radial velocity.

"It cannot be due to the effect of stream-motion.

"The giant and dwarf division among the K and M stars is indicated clearly in the absolute magnitudes.

"The stars of types K and M have mean velocities about 1.0 or 1.5 km higher than the F and G stars of the same absolute magnitude."

GALILEO.

By night the stars spake unto me:—
"Humble sky-child, thirst thou for the Infinite?
Would'st be one with us—to know all, be free,
Hearken us and be wise.
In us will you find friends, counsellors, defenders;
Through us inspiration, courage, solace.
When the world's best shall fail you.
Trust then, and fear not!"

Thus in their burning symbols
I live and move and have another being.
They teach me truths, rich, strange and beautiful,
But far beyond my time.
Dare I but hint these oracles abroad—
Relay these sun-blazed tidings? God forbid!
On tower-top I commune in secret, dumb.
Friends fear to own me friend, spies trap each port.
Hark! the dread echoes of the Council's curse,
The whip's red slash, the brand-iron's hiss, the crackle of fagots,
And I remember Bruno!

So be it! In secret cipher
I pen these glimpses into things eternal.
For well I know, praise God!
A generation comes to hearken and rejoice
That here and now
The immortal, the enduring and the just
Make humble me their mortal instrument.
Yea, verily,
Far peoples in far centuries who shall give
Proud thanks that I—
Poor, blind, despised, imprisoned Galilei—
Lived!

C. E. BARNS.

Morgan Hill, Cal.